Gravatt, Dan

From:

Gravatt, Dan

Sent:

Tuesday, May 14, 2013 6:49 AM

To: Subject: Tapia, Cecilia; Hammerschmidt, Ron; Hood, Rich Questions from Harvey Ferdman on West Lake Landfill

Subject: Attachments:

U235 Ratio and RA226 228 with Udg Smoldering Event Map.jpg; Miss River and Rulo

Combined.jpg; Groundwater Monitoring Report.pdf; Dr Criss - West Lake Rept03142013.pdf;

SFS Executive Summary.pdf

What do we need/want to do to respond to this?

Daniel R. Gravatt, PG US EPA Region 7 SUPR/MOKS 11201 Renner Boulevard, Lenexa, KS 66219 Phone (913)-551-7324

Principles and integrity are expensive, but they are among the very few things worth having.

From: Jefferson, Matthew

Sent: Friday, May 10, 2013 6:19 PM

To: Singletary, DeAndre; Gravatt, Dan; Asher, Audrey

Subject: FW: West Lake Landfill

fyi

From: Harvey Ferdman [mailto:HarveyFerdman@aol.com]

Sent: Saturday, April 27, 2013 10:46 PM **To:** Washburn, Ben; Jefferson, Matthew

Cc: Bill.Otto@house.mo.gov Subject: FW: West Lake Landfill

Matt and Ben,

Thank you for your interest in helping the people effected by the radioactive materials in and around Cold Water Creek and the West Lake Landfill.

I think we all feel for the residence who have been effected by this. With your help, and the help of many more of our government employees and our citizens, I hope we can reduce the risk for those living near the West Lake Landfill and take care of those already suffering negative effects from the weapons waste in the St. Louis area from WW2.

Here's some of the information I have to share with you. I have combined 2 emails together below. The first one (EMAIL 1 below) was sent to both Christopher Clayton (FUSRAP, DC) and Sarah Hatch (EPA Lenexa). The second one (EMAIL 2 below) was sent to Sarah Hatch (EPA) after a conference call with her and the project manager(s) and other staff in Lenexa that are responsible for the West Lake site.

Your assistance is appreciated.

Thanks for your work at the meetings in St. Louis. I think you have given these people hope that their situation will be properly addressed by our government.

0714



320

Regards, Harvey

Harvey Ferdman

Policy Advisor to Missouri State Representative Bill Otto, District 70 St. Louis, MO 63017 314-469-0595 314-761-5100 (cell)

EMAIL 1:

From: Harvey Ferdman [mailto:HarveyFerdman@aol.com]

Sent: Tuesday, April 23, 2013 2:49 PM **To:** <u>Christopher.Clayton@hq.doe.gov</u>

Cc: <u>Bill.Otto@house.mo.gov</u> **Subject:** West Lake Landfill

Christopher,

Thank you for your time on 4/11/2013 to discuss the possibility of the FUSRAP program taking charge of the West Lake Landfill in Bridgeton Missouri.

Have you had an opportunity to look into this?

Harvey Ferdman

Policy Advisor to Missouri State Representative Bill Otto, District 70 St. Louis, MO 63017 314-469-0595 314-761-5100 (cell)

Thank you for your time and interest in helping us answer questions raised by our constituents regarding the issues and challenges at the West Lake / Bridgeton Landfill.

Just to make things more interesting, the tornado that hit here on Wednesday evening April 10, 2013 was 3 blocks from the West Lake site, which is also the home of a "subsurface smoldering event" (SSE) less than 1300 feet from the radiologically-impacted materials (RIM) deposits. The SSE is commonly referred to as a dump fire. This SSE is currently growing in size and efforts to control it have become increasing challenging as it spreads.

I have included the following for your review. I call your attention to Dr. Criss' paper which clearly states that the chemical analysis of the performed by the NRC <u>DOES NOT</u> show the proper ratios of barium to sulfate to indicate that the original RIM was the end product of the process used by Mallinckrodt, but rather, indicates the RIM is much more dangerous than the barium sulfate the EPA states is there. I mention this because all subsequent decisions regarding this site have been based on the assumption that the RIM is barium sulfate.

Republic Services (current owner of the West Lake Landfill):

Attorney who stated to me that the owner at the time the RIM was placed there did not know it was RIM Jessica E. Merrigan of Lathrop & Gage LLP. Direct Line: 816-460-5706

JMerrigan@LathropGage.com

Note: It appears the RIM was moved to West Lake in 1973.

Attachments:

West Lake - Inside EPA ... pdf

References May 4, 2009 letter from Missouri DNR to acting DPA Region VII Administrator, William Rice to excavate this site (page 8)

States that the West Lake Landfill is not regulated by the NRC (found on Page 2) States the following (page 3)

A 1988 report by the NRC indicates that the average radium-226 concentration at the West Lake site is about 90 pCi/g, 18 times above the 5 pCi/g ARAR. In addition, the NRC report says radium-226 activity will increase over time, increasing nine-fold over the next 200 years, or 162 times above the ARAR. "This increase in Ra-226 must be considered in evaluating the long-term hazard posed by this radioactive material," the NRC report says.

And, according to a 1982 NRC report, some samples taken at the West Lake site indicate radium-226 concentrations as high as 21,000 pCi/g, or 4,200 times above the ARAR. Relevant documents are available on InsideEPA.com

References a letter from Missouri DNR to EPA Administrator Lisa Jackson against the plan to cap the RIM in place (page 5)

References numerous local governments that have urged removal vs. capping in place (page 5 and others)

U235 Ratio and RA226 228 with Udg Smoldering Event Map.jpg Ground Water Monitoring Report.pdf

This map and source document for EPA data that shows that ground water in areas of the West Lake Landfill that did not have RIM directly deposited on them are now showing the presence of U235, U238, U234 and RA 226 and RA 228 in amounts greater than the background generally found in this part of our state. The original, unmodified map is found on Page 84 of the Ground Water Monitoring Report dated Dec 2012. I added the data in brown (from Table 6 of the same document) as well as a rough outline of the area that has the "underground smoldering event" (commonly referred to as the fire). Note: The Ground Water Monitoring Report, dated December 14, 2012 was prepared for EPA by EMSI.

This raises a number of questions, including the following:

- Does this mean that Bridgeton Landfill (OU-2) is contaminated with radioactive materials? If so, is it possible some of the waste from Latty Avenue was dumped into OU-2 in addition to OU-1?
- The data seems to prove that the groundwater is being contaminated with radioactive materials. This is especially relevant because reports from both the EPA and the PRPs say that the radioactive materials are not affecting the groundwater although it appears that their own data contradicts this conclusion.

Dr Criss - West Lake Rept03142013.pdf

http://eps.wustl.edu/people/bob criss Dr. Criss appears to be a qualified party to comment on the investigations and subsequent conclusions that the EPA has conducted and arrived at regarding the risk assessment of the West Lake Landfill. His paper (see attachment) details many of his concerns about how the studies were conducted, how the data was interpreted, and the conclusions that were drawn.

Note: Dr. Criss' paper and concerns listed within have become focal point of the surrounding community. It is wise for any solution for the final disposition of the West Lake Landfill to directly address all the issues raised in Dr. Criss' paper or public acceptance of said solution will be in jeopardy

SFS Executive Summary.pdf

This document (Supplemental Feasibility Report dated December 28, 2011) was prepared for the PRPs by EMSI (the same contractor the EPA uses for their analysis). It this paper, they make statements regarding the ground water and other hazards that contradict their own data (see Dr. Criss' paper and U235 Ratio Map). Republic states that their SFS has been "accepted by the EPA".

Dr. Criss' paper and the Executive Summary of the Supplemental Feasibility Report dated December 28, 2011 that was **prepared on behalf of the PRPs by EMSI** and referenced by Republic as having been accepted by EPA. Note that both the EPA and the PRPs are contracting with the same firm (EMSI) for the technical analysis of this site. Republic's statement in conjunction with Dr. Criss' paper have become the cause of great concern in the public's minds regarding checks and balances and objectivity of the reports as well as fueling Dr. Criss' criticism that the proper analysis of the site is not being performed by either the EPA or the PRPs ... **since EMSI is not the only firm that can perform these studies, is it possible for DOE to commission a truly independent study?**

Miss River and Rulo Combined.jpg

These charts show that flood levels are rising in local rivers. The Missouri River at Rulo has exceeded 25-year levels 4 times in the last 6 years, exceeded 100-year levels 2 times in the last 3 years, and exceeded the 200-year level one time in the last 2 years, almost reaching the 500-year level. A chart showing similar trending for the Mississippi was also handed out.

Relevance: the analysis done for EPA and the PRPs by EMSI site the existence of a 500 year levee as adequate to protect the radioactive materials if they are left in place. With changing precipitation patterns and additional constriction of the river upstream by updates and additions to upstream levees, it would appear that the definition of a 500-year flood needs recalibration, and, therefore, protecting to the current definition of a 500 year flood may be grossly inadequate.

West Lake - rad.charts - Kay Drey.pdf

Contains a collection of unusually high radioactive readings for RIM at West Lake Landfill and a cover letter containing a brief history of the RIM stored there.

Please let me know if you have any questions or need further information that we may be able to assist with.

We look forward to your review of this situation.

Sincerely, Harvey

Harvey Ferdman

Policy Advisor to Missouri State Representative Bill Otto, District 70 St. Louis, MO 63017 314-469-0595 314-761-5100 (cell)

EMAIL 2:

Sent to Sarah Hatch (EPA) 4/16/2013

Sarah,

Thanks for setting up the call today.

I sometimes view my role in this matter as that of an arbitrator.

It that spirit, I contacted Dr. Criss and asked if he would agree that the ratios and amounts of barium and sulfate sited in Table 13 of the 1982 NRC report (see attached / Report page 109, PDF page 117 and image below) could indicate barium-sulfate that has been mixed with other materials as was discussed during today's conference call.

Here's his response:

Many reports site that there were originally 8,700 tons of Barium-Sulfate mixed with 39,000 tons of clean dirt that constitutes the 47,700 tons of radioactive material that was deposited at West Lake Landfill.

If Barium Sulfate is the format for the Radioactive Material, then Barium-Sulfate should be present in amounts greater than background and those amounts should be consistent with the amount of radioactivity recorded from the samples. Since the samples taken by the NRC show close to or below background levels, he concludes that there is not an additional deposit of barium-sulfate present.

The NRC table shows background for Barium at 250 ppm and sulfate at 20 ppm. Note that two of the boreholes (#101 and #104) show below background for sulfate, indicating there is radioactivity present w/o additional sulfate present, implying that the radioactive material is not barium sulfate.

He further notes that to dilute waste barium sulfate to the levels present in the NRC samples would be virtually impossible to achieve: see math below

Per Dr. Criss:

In ppm, Barium Sulfate is:

580,000 ppm barium 420,000 ppm sulfate

The highest sample (Area 1, Borehole #103) shows 2386 ppm barium and 121 ppm sulfate. If the radioactive material started out as barium sulfate, the dilution rations would have to be as follows in order to match the observed data, which, as the numbers show, is highly unlikely if not impossible given the original 8700 tons of barium-sulfate and 39,000 tons of clean dirt allegedly deposited at the site:

580,000 / 2386 = 243 times the original volume of barium would be necessary to achieve this dilution. This means instead of 39,000 tons of clean dirt, 2,114,100 tons of clean dirt would have been required. 420,000 / 121 = 3471 times the original volume of sulfate would be necessary to achieve this dilution. This means instead of 39,000 tons of clean dirt, 30,197,700 tons of clean dirt would have been required.

Note: given the original reported volume of barium-sulfate and dilution material, the ratio of dilution to barium-sulfate appears to be 4 to 1 (39,000 tons total mixed deposit at West Lake / 8700 tons Barium Sulfate), which is significantly different than the 243 or 3471 to 1 calculated above based on observed data. Dr. Criss therefore asserts that the radioactive materials present at West Lake are not predominantly barium-sulfate and is recommending further testing be done to prove or disprove this.

Note: the numbers above use maximum amount of barium measured at the site and do not account for the presence of background barium and sulfate in the material used for dilution. Accounting for these would increase the volume of material necessary to match the observed data.

Based on the above, Dr. Criss is recommending that better evidence for the presence of barium-sulfate be documented or the claim be dismissed.

Dr. Chriss has recommended that if the materials that were extacted from the site to determine the "hot spots" are availabe, a complete chemical analysis be performed on them includeing testing for barium sulfate. If these samples are not avialable, new ones should be obtained and anlayzed.

Chemical Analysis of Radioactive Material From Areas 1 and 2

Table 13

Concentration in ppm

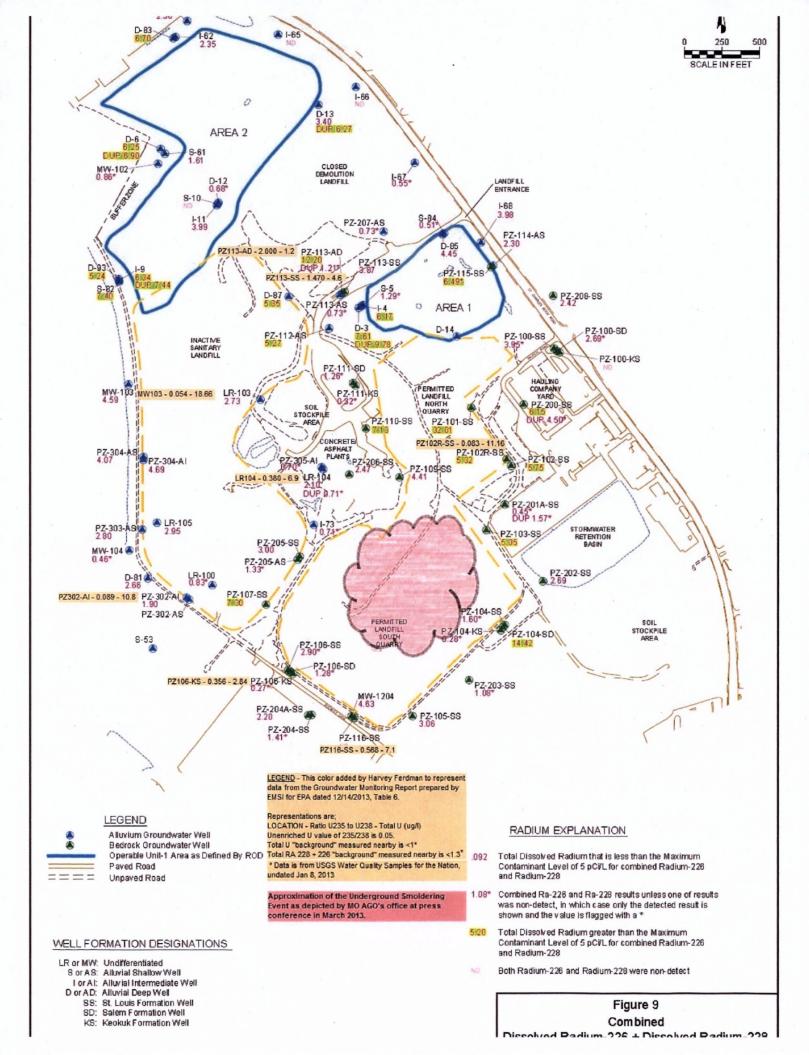
| | Offsite > Bkg Sample | Area 1 Surface (#101) | Area 1 Surface (#102) | Area 1 Borehole (#103) | Area 2 Surface (#104) | Area 2 Surface (#105) |
|---------|----------------------------|-----------------------------|-----------------------------|------------------------------|-----------------------------|-----------------------------|
| Barium | 250 | 300 | 1811 | 2386 | 1158 | 1197 |
| Lead | 16 | 15 | 108 | 121 | 11 | 50 |
| Zinc | 132 | 146 | 94 | 76 | 28 | 167 |
| Sulfate | 20 | 15 | 108 | 121 | 11 | 50 |

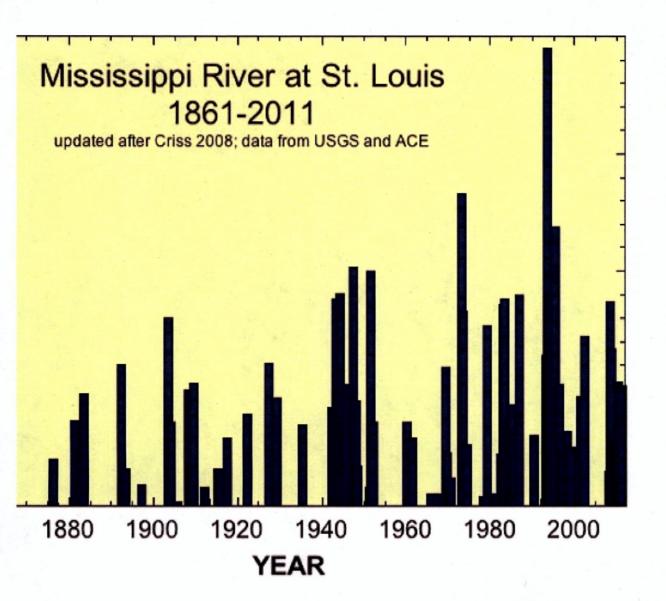
* sekground

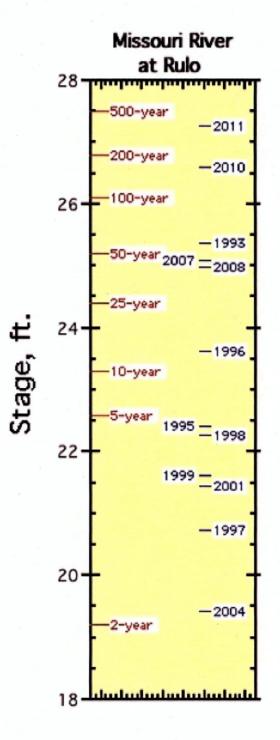
Thank you for your assistance and guidance in resolving this issue.

Regards, Harvey

Harvey Ferdman
Policy Advisor to
Missouri State Representative Bill Otto, District 70
St. Louis, MO 63017
314-469-0595
314-761-5100 (cell)







Groundwater Monitoring Report

2012 Additional Groundwater Sampling Event

West Lake Landfill Operable Unit-1

Prepared for

The United States Environmental Protection Agency Region VII

Prepared on behalf of

The West Lake Landfill OU-1 Respondents

Prepared by

Engineering Management Support, Inc. 7220 West Jefferson Avenue, Suite 406 Lakewood, Colorado 80235

December 14, 2012

EXECUTIVE SUMMARY

In May 2012 the U.S. Environmental Protection Agency, Region VII (EPA) directed the West Lake Landfill Operable Unit-1 (OU-1) Respondents to perform an additional round of groundwater sampling at the West Lake Landfill Superfund Site (site). EPA indicated that, following consultation with the National Remedy Review Board, it believed additional groundwater monitoring was necessary to verify that current groundwater conditions are consistent with prior sampling performed in 1995, 1996, and 1997 as part of the Remedial Investigation, and in 2004 as part of the Feasibility Study. These prior rounds of groundwater sampling formed part of the basis for EPA's May 2008 Record of Decision (ROD) concerning the site, which at pages 20-21 determined that:

The alluvial groundwater underlying and in the immediate vicinity of [OU-1] Areas 1 and 2 and other [OU-2] landfill units have been sampled and analyzed over time. For radionuclides and metals, both filtered and unfiltered samples were analyzed to evaluate dissolved versus colloidal transport. The results generally show sporadic and isolated detections of a small number of contaminants at relatively low concentration levels. These results are not indicative of on-site contaminant plumes, radial migration, or other forms of contiguous groundwater contamination that might be attributable to the landfill units being investigated. . . .

This Groundwater Monitoring Report summarizes the results of the 2012 additional groundwater sampling event. The new event sampled all available groundwater monitoring wells at the site, including wells for OU-1 (the areas of the site containing radiologically-impacted material [RIM]), and for OU-2 (the remainder of the site which contains landfilled solid waste but not RIM). The sampling tested for three "radiological" materials (uranium, thorium and radium), and three types of "conventional" landfill contaminants (priority pollutant trace metals, volatile organic compounds [VOCs], and semivolatile organic compounds [SVOCs]).

The results of this new 2012 sampling event support EPA's May 2008 ROD conclusion: isolated and sporadic detections of a small number of radiological and conventional contaminants exist in site groundwater, but no contiguous plumes of radiological or conventional groundwater contaminants are present underneath the site or migrating from the site.

With respect to radionuclides, uranium is not present in site groundwater above its respective EPA-established Maximum Contaminant Level (MCL), and thorium is also present only at low levels.

Two forms of radium are present in the site groundwater: Radium-226 and Radium-228. EPA's MCL for radium is set at 5 picocuries per liter for the combination of Radium-226 plus Radium-228. Both Radium-228 and Radium-226 naturally occur in soil and rock, and published scientific studies indicate that the highest levels of combined radium found in national groundwater sampling events are located in a five state region which includes Missouri. Radium-228 generally is not present at levels above background in the RIM previously sampled at OU-1, and therefore any elevated levels of Radium-228 found in site groundwater are not attributable to the OU-1 RIM. With respect to Radium-226, the highest levels of Radium-226

were found in bedrock monitoring wells upgradient of those areas of the site which contain RIM. The absence of any spatial relationship between the RIM locations and the radium exceedances indicates that the Radium-226 and Radium-228 found in site groundwater are of natural origin. There are no locations where multiple wells placed near each other all displayed high radium levels or where the sampling results produced a pattern of spatially-linked increasing or decreasing radium results that would suggest a discrete source or sources for radium other than the site's natural media – i.e, the rock and soil surrounding the landfills.

Similarly, although there were isolated occurrences of trace metal, VOC and SVOC exceedances, the spatial pattern and lack of repeated, increasing or decreasing levels of these substances indicate that there is no distinct plume or area of groundwater impacts from conventional contaminants.

Accordingly, EPA's May 2008 ROD analysis of site groundwater sampling results remains valid: "The results generally show sporadic and isolated detections of a small number of contaminants at relatively low concentration levels. These results are not indicative of on-site contaminant plumes, radial migration, or other forms of contiguous groundwater contamination that might be attributable to the landfill units being investigated."

Table of Contents

| 1. | Intro | roduction | 1 |
|----|-------|--------------------------------------|----|
| 2. | Field | eld and Sample Collection Activities | 1 |
| 3. | Lab | boratory Analyses | 3 |
| 4. | Data | ta Validation | 4 |
| 5. | Gro | oundwater Levels | 6 |
| 6. | Gro | oundwater Sample Results | 8 |
| 6 | 5.1 | Radionculides | 8 |
| | 6.1. | .1 Uranium | 8 |
| | 6.1.2 | .2 Thorium | 9 |
| | 6.1.3 | .3 Radium | 9 |
| 6 | 5.2 | Trace Metals | 13 |
| 6 | 5.3 | Volatile Organic Compounds | 14 |
| 6 | 5.4 | Semi-Volatile Organic Compounds | 15 |
| 7. | Sum | mmary and Conclusions | 16 |
| 8. | Refe | ferences | 17 |

List of Tables

- Table 1: Groundwater Level Measurements (July 30, 2012)
- Table 2: Wells Sampled During the Additional OU-1 Groundwater Sampling Effort
- Table 3: Vertical Groundwater Gradients (July 30, 2012)
- Table 4: Comparison of 2012, 2011 and 1997 Groundwater Levels
- Table 5: Annual Precipitation St. Louis Lambert Field
- Table 6: Summary of Uranium Results from OU-1 Additional Groundwater Sampling
- Table 7: Summary of Thorium Isotope Results from OU-1 Additional Groundwater Sampling
- Table 8: Summary of Radium Isotope Results from OU-1 Additional Groundwater Sampling
- Table 9: Summary of Average, Median and Maximum Radium Results
- Table 10: Comparison of Radium-226 Results from Duplicate Samples
- Table 11: Comparison of Radium-228 results from Duplicate Samples
- Table 12: Comparison of Radium Results from OU-1 and MDNR Split Samples
- Table 13: Summary of the 2012 Radium-226 Results to the Prior RI/FS Results
- Table 14: Summary of Detected Trace Metal Results
- Table 15: Summary of Most Frequently Detected Volatile Organic Compounds
- Table 16: Summary of Detected Semi-Volatile Organic Compounds

Table of Contents (cont.)

List of Figures

- Figure 1: Base Map
- Figure 2: Alluvial Groundwater Table and St. Louis Formation Potentiometric Elevation Map
- Figure 3: Annual Precipitation 1937 2012 St. Louis Lambert Field
- Figure 4: Total Radium-226 in Groundwater
- Figure 5: Dissolved Radium-226 in Groundwater
- Figure 6: Total Radium-228 in Groundwater
- Figure 7: Dissolved Radium-228 in Groundwater
- Figure 8: Combined Total Radium-226 plus Total Radium-228 in Groundwater
- Figure 9: Combined Dissolved Radium-226 plus Dissolved Radium-228 in Groundwater
- Figure 10: RI/FS Results for Total Radium-226 in Groundwater
- Figure 11: RI/FS Results for Dissolved Radium-226 in Groundwater

List of Appendices (on Compact Disk)

- A. Field Data Sheets
 - A.1. Monitoring Well Conditions Reports
 - A.2. Groundwater Elevation Measurements
 - A.3. Groundwater Sampling Field Information Logs
 - A.4. Groundwater Sample Chain-of-Custody Forms
 - A.5. 2012 Monitoring Well Survey Data
- B. Analytical Laboratory Reports
 - B.1. Eberline Laboratory Analytical Reports
 - B.2. Test America Analytical Reports
- C. Data Validation Reports and Analytical Database with Data Qualifiers
 - C.1. Data Validation Reports
 - C.2. Analytical Database with Data Qualifiers

1. INTRODUCTION

In May 2012 the U.S. Environmental Protection Agency, Region VII (EPA) directed the West Lake Landfill Operable Unit-1 (OU-1) Respondents to perform an additional round of groundwater sampling at the West Lake Landfill Superfund Site. Engineering Management Support Inc. (EMSI), on behalf of Cotter Corporation (N.S.L.), Bridgeton Landfill, LLC and Rock Road Industries, Inc., and with funding provided by the United States Department of Energy (collectively, the OU-1 Respondents), prepared this report presenting the results of that additional groundwater sampling.

EPA indicated in May 2012 that, following consultation with the National Remedy Review Board, it believed additional groundwater monitoring was necessary to verify that current groundwater quality is consistent with conditions characterized during sampling performed in 1995, 1996, and 1997 as part of the Remedial Investigation (EMSI, 2000), and in 2004 as part of the Feasibility Study (EMSI, 2006) activities for OU-1. EPA required that all available groundwater monitoring wells at the West Lake Landfill Superfund Site be included in the groundwater sampling event, including wells for OU-1 (Radiological Areas 1 and 2 which contain radiologically-impacted materials [RIM]) and OU-2 (the remainder of the Site which did not receive RIM, including the Inactive Sanitary Landfill, the Closed Demolition Landfill, and the former Permitted Landfill's North and South Quarry units). EPA further directed that the samples obtained from these wells be analyzed for uranium, thorium and radium radioisotopes (both total [unfiltered samples] and dissolved [filtered samples] phases); total and dissolved phase trace metals; volatile organic compounds (VOCs); and semivolatile organic compounds (SVOCs).

This report presents the results of those additional groundwater monitoring activities and contains the following information:

- Description of the field and sample collection activities;
- Results of the laboratory analyses of the groundwater samples; and
- Evaluation of the sample results.

This report also contains copies of the various field data sheets (Appendix A), the analytical laboratory reports (Appendix B), and the data validation reports and resultant database (Appendix C). Due to the size of these documents, the appendices are contained on the included compact disk.

2. FIELD AND SAMPLE COLLECTION ACTIVITIES

A Sampling and Analysis Plan (SAP) and associated planning documents were prepared to describe the proposed monitoring locations, sample collection procedures, analyte list, laboratory analyses, quality assurance/quality control samples and procedures, investigative-derived waste

management, health and safety procedures, data evaluation and management procedures, and a tentative schedule for the work (EMSI, 2012). EPA approved the SAP by letter dated July 3, 2012.

Upon receipt of EPA approval of the SAP and prior to sample collection, limited brush clearing was performed to assist in locating the various groundwater monitoring wells and to provide physical access to the monitoring well locations. In addition, shallow excavations of very limited extent were performed in the areas where monitoring wells were suspected to present at the Site, but may have been buried during Site grading activities. Finally, repairs were made to the surface and/or shallow subsurface portions of those well casings that had been found to be damaged during the initial well inspection. All of these activities were consistent with EPA's instructions to include the maximum number of wells in the sampling event.

The groundwater sampling event began on July 30, 2012 with well inspections and collection of a complete set of water level measurements from 76 of the 77 monitoring wells that had been located during the initial inspection. A water level could not be obtained from well PZ-108-SS due to ongoing post-closure landfill cover construction activities in the vicinity of this well. Additionally, monitoring well D-14 had not been located during the initial inspection but was subsequently found during the groundwater sampling activities, and a water level measurement was obtained from this well on August 7, 2012. Table 1 presents a summary of the groundwater level measurement data obtained from all of the wells. Copies of the well inspection and groundwater elevation measurement and the groundwater monitoring well condition report forms are contained in Appendix A.

The location and elevation of the monitoring wells were re-surveyed as part of the additional groundwater sampling event. Surveying was performed by a Missouri licensed land surveyor provided by AquaTerra. The results of the well survey are contained in Appendix A. A base map showing the locations of the monitoring wells and various Site features is presented on Figure 1.

Collection of groundwater samples began on July 31, 2012, and continued on a daily basis five days a week until sampling activities were completed on August 16, 2012. Groundwater samples were collected by Herst & Associates personnel in accordance with the procedures set forth in the SAP. Copies of the Field Information Logs from the groundwater sampling activities are contained in Appendix A. Copies of the chain of custody forms are also included in Appendix A.

Groundwater samples were obtained from 75 (of 78 total located) monitoring wells or piezometers at the Site (Table 2). Two wells (S-53 and PZ-302AS) near the southern portion of the Inactive Sanitary Landfill were dewatered during well purging activities but the water levels in these wells did not recover sufficiently to allow collection of groundwater samples. Additionally, due to insufficient water, only a partial list of analyses could be completed on the samples obtained from wells S-82 (radionuclides and VOCs only) and D-14 (total phase radionuclides only). Finally, neither a water level nor a groundwater sample could be obtained from well PZ-108-SS due to ongoing cover construction activities in the vicinity of this well. This well is routinely sampled (although not for radionuclides) as part of the permitted landfill

groundwater monitoring program. Eight field duplicate groundwater samples were also obtained during the course of the groundwater sampling activities (Table 2).

EPA was present for sampling activities conducted the afternoon of August 6 and all day on August 7 and 8, 2012. During this period EPA obtained split samples from eleven wells (Table 2). MDNR and EMSI personnel were also present to observe the sampling activities on August 6 and 7, 2012. MDNR was again present on August 14, 2012 and obtained split samples from five wells on that date (Table 2).

3. LABORATORY ANALYSES

Samples for radionuclide analyses were shipped by Federal Express to Eberline Services Oak Ridge, TN laboratory (Eberline). The sampling crews delivered samples directly to the Test America St. Louis laboratory (Test America) for chemical analyses.

Eberline analyzed the samples for Radium-226 using EPA Modified Method 903.0; for Radium-228 using EPA Modified Method 904.0; for Thorium-228, -230 and -232 using EML Modified Method Th-01; and for Uranium-234, -235, and 238 using EML Modified Method U-02. The Eberline Analytical Reports are contained in Appendix B. The Eberline analytical laboratory reports include the laboratory results, the combined standard uncertainty (CSU), the minimum detectable activity (MDA) levels, and associated laboratory documentation related to sample receipt, handling, preparation and analysis.

EPA along with other agencies has developed the Multi-Agency Radiological Laboratory Analytical Protocols (MARLAP) Manual to address the need for a nationally consistent approach to producing radioanalytical laboratory data (EPA, 2004). MARLAP states that an important aspect of sampling and measurement is uncertainty. The Combined Standard Uncertainty (CSU) can be viewed as the statistical standard deviation of an individual radiological result (McCurdy et al., 2008). The concentration of a radiological constituent in a sample is typically calculated using a mathematical equation that includes such parameters as the measured signal response of a radiation detector (events per time unit), the detector background signal response, the detector efficiency for the radiation emission producing the response, sample aliquant size processed, chemical yield of the radiochemical process, and decay and ingrowth factors based on the halflife of the radionuclide or its decay product. Each measurement parameter in the equation has its own uncertainty defined as a standard uncertainty. The CSU of the final result is determined using the common statistical approach that the variance (squared CSU) of a function of several variables can be approximated by applying the function to the variance of each variable component (for example, MARLAP, chapter 19 [EPA, 2004]). Using this logic, the CSU of a radiological result is the square root of a sum of variances. When a concentration and its associated CSU are reported, a confidence interval can be calculated that defines the range of concentration (the lower and upper concentration) for the "true concentration" with a certain confidence. For this project, Eberline calculated and reported the CSU at the 95%-percent or 2sigma confidence level (analogous to the standard confidence level used when reporting the standard deviation for other water-quality results). The confidence level that is used when

interpreting or publishing radiological results is dependent on the Data Quality Objectives (DQOs) of the project. Reporting the concentration with its corresponding CSU (as provided in the data) provides the 95-percent confidence interval.

Test America analyzed the samples for VOCs by gas chromatography/mass spectrometry (GC/MS) using EPA Method 8260C; for SVOCs by GC/MS using EPA Method 8270D; for the Target Analyte List (TAL) trace metals by Inductively Coupled Plasma (ICP) using EPA Method 6010C; and for Mercury by Cold Vapor Atomic Adsorption (CVAA) using EPA Method 7470A. The Test America Analytical Reports are included in Appendix B.

In addition to the analyses requested by EPA, the samples were analyzed for chemistry characterizations: major anions by Ion Chromatography (IC) using SW-846 Method 300.0; major cations by ICP using EPA Method 6010C; alkalinity by SW-846 Method 310.1; and bromide and iodide by IC using SW-846 Method 300.0. Results of these analyses can also be found in the Test America Analytical Reports included in Appendix B.

4. DATA VALIDATION

A Level III validation was performed consisting of manually examining data deliverables to determine data quality. All data were validated using method applicable guidelines and in accordance with the requirements of the National Functional Guidelines for Organic and Inorganic Data Review (EPA, 2008a and 2010) and by SW-846 guidelines specific to the method. Radionuclides were validated according to the guidelines and criteria specified in the MARLAP Manual (EPA, 2004). Data validation included application of data qualifiers to the analytical results based on adherence to method protocols and project-specific QA/QC limits. The data validation reports for each sample delivery group are included in Appendix C.

Method protocols reviewed included:

- Analytical holding times,
- Method blanks (MB),
- Trip blanks (TB),
- Equipments Blanks (EBs),
- Matrix spikes/matrix spike duplicates (MS/MSDs),
- Laboratory control samples (LCSs),
- Shipping cooler temperatures,
- Laboratory duplicates,
- Internal Standards (ISs),
- Surrogates, and
- Chemical recovery (radionuclides).

Based on the data validation, the appropriate data qualifiers, if any, were added to the analytical results. An analytical database that includes the applied data qualifiers is included in Appendix C.

Data quality assessment (DQA) criteria were used to evaluate the quality of the field sampling efforts and laboratory results for compliance with project DQOs. The DQA criteria are expressed in terms of analytical precision, accuracy, representativeness, completeness, and comparability (PARCC).

Precision is the measure of variability between individual sample measurements under prescribed conditions. The relative percent difference (RPD) for the field duplicate, matrix spike/matrix spike duplicate (MS/MSD), and laboratory duplicate analyses demonstrate the precision of the analytical methods. An RPD within the method-specific control limit indicates satisfactory precision in a measurement system. For this sampling event, duplicate results were predominantly in control.

Accuracy is the degree of agreement of a measurement with an accepted reference or true value. The results of surrogate, MS/MSD, chemical recovery, and LCS analyses, when expressed in terms of percent recovery, demonstrate the accuracy of the method. Accuracy results for all methods and matrices are predominantly in control. The accuracy results which were out-of-control are not significant for any one compound, method, or matrix and do not represent a negative impact to data quality. Therefore, overall accuracy for this sampling event was acceptable.

Representativeness. Sample data are believed to be representative of the site conditions prevailing at the time of sample collection because most of the samples were properly collected, stored, and preserved. One SDG (160-428) was qualified as estimated because the cooler temperature was above 6°C. VOCs in one SDG (160-420) were qualified as estimated because the sample pH was greater than 2 and the samples were analyzed one day out of the 7-day unpreserved holding time. Although blank contamination did occur (mostly with common lab contaminants), sample data quality was not adversely affected.

Comparability. All samples were reported in industry-standard units. Water reporting units were micrograms per liter ($\mu g/L$), milligrams per liter (mg/L) or picocuries per liter (pCi/L). Analytical protocols for the methods were adhered to (with the exceptions noted in this report) and analytical results are considered comparable.

Completeness is defined as the percentage of laboratory measurements judged to be valid on a method-by-method basis. Valid data are defined as all data and/or qualified data which meet the DQOs for this project. Data completeness is expressed as percent complete (PC), which is calculated as follows: (the number of rejected samples per compound ÷ total number of samples per compound) X 100. Completeness is 100%, understanding that all results qualified with U, UJ or J are usable to meet the project objectives of this sampling event. The goal for meeting analytical holding times was 100% and was not met for only one set of VOC samples.

Sensitivity was evaluated using the RLs and MDLs for each sample as compared to project maximum allowable RLs. The laboratory RLs met required RL limits for most compounds except when adjusted for sample dilution. For radionuclides, when the sample results are greater than the MDA but have a combined standard uncertainty less than 50% of the sample activity, the sample is qualified with a J. This is an indication that the value is near the MDA and has a relatively large combined standard uncertainty compared to the sample result.

The groundwater data are of acceptable quality and are considered usable to support the project objectives for this sampling event. Samples are representative of the Site when used in accordance with the validation qualifiers.

5. GROUNDWATER LEVELS

Groundwater is present within the alluvium and bedrock deposits beneath the Site. The edge of the geomorphic floodplain for the Missouri River was evaluated as part of the Supplemental Feasibility Study (EMSI, 2011) and was determined to be located beneath the southeastern portion of the Site (Figure 2). To the northwest of this boundary, the uppermost (shallowest) groundwater occurs within the alluvial deposits. Because alluvium is not present beneath the southeastern portion of the Site, the uppermost groundwater is found in bedrock of the St. Louis Formation.

Water level measurements were obtained from the monitoring wells (Table 1), and these data were used to develop a potentiometric surface (water level) map for the Site (Figure 2). Groundwater within the St. Louis Formation beneath the southeastern boundary of the Site displays the highest water level elevations [generally from 440 to 460 feet (ft) above mean sea level (amsl)], whereas the lowest groundwater elevations (approximately 429 to 429.5 ft amsl) are present within the alluvial deposits along the northern portion of the Site. These data indicate that the overall direction of the hydraulic gradient in the area of the Site is to the northwest, towards the Missouri River.

The water level data also indicate that overall, groundwater within the bedrock generally discharges to the alluvial deposits at the Site (Figure 2). With the exception of the area immediately around the quarry landfills, the water levels in the bedrock (e.g., PZ-208-SS, PZ-201A-SS, PZ-102-SS and PZ-102R-SS) are substantially higher (i.e., 440 to 450 ft amsl) than the water levels in the alluvial deposits (i.e., 430 ft amsl), indicating that groundwater flows from the bedrock into the alluvium. In addition, water level data obtained from co-located alluvial and bedrock wells support the conclusion that groundwater within the bedrock discharges to the alluvium. The water level data indicate that the water levels within the bedrock wells are generally higher than the water levels in the nearby alluvial wells indicating that beneath the Site an upward gradient generally exists from the bedrock to the alluvium. For example, compare the water level elevations between St. Louis Formation well PZ-205-SS (430.22) to that of the colocated alluvial well PZ-205-AS (429.67), or compare the water level elevations between St. Louis Formation well PZ-113-AS (429.85) and PZ-113-AD (429.86) (Table 3 and Figure 2).

A downward gradient is present within the bedrock in the immediate area of the permitted quarry landfills (outside of the OU-1 areas) where ongoing extraction of groundwater and leachate from the permitted North and South Quarry Landfills has created a localized depression in the St. Louis Formation potentiometric (water level) surface (Figure 2). Pumping from the quarry landfills is performed to maintain an inward hydraulic gradient into the quarry landfills. The extracted water is discharged to the Metropolitan St. Louis Sewer District (MSD), a Publicly Owned Treatment Works (POTW), in accordance with all required permits. The presence of a hydraulic gradient towards the quarry landfills is demonstrated by the presence of lower water levels in wells PZ-115-SS and PZ-101-SS which are located close to the quarry landfills as compared to the water levels in other St. Louis Formation wells such as PZ-208-SS and PZ-102R-SS. Although a localized depression exists in the potentiometric surface of the St. Louis Formation in this area, the limited extent of this localized depression combined with the absence of alluvium in this area indicates that this pumping does not result in a downward gradient from the alluvial aquifer to the bedrock in this area.

Review of water level data obtained from well clusters completed within the alluvial deposits beneath the northern portion of the Site (Table 3) indicates that, in general, the highest water levels are found in the shallower alluvial wells that are completed in the upper portion of the alluvium and lower water levels are generally present in the deeper alluvial wells that are completed near the base of the alluvial deposits (e.g., compare water levels from S-5, I-4, D-3 and S-84 and D-85 well clusters near OU-1 Area 1, the S-10, I-11 and D-12; S-82, I-9 and D-93; S-61, MW-102 and D-6, and I-62 and D-83 well clusters near Area 2). These data indicate that a slight downward hydraulic gradient is present within much of the alluvial deposits beneath the northern portion of the Site.

The hydraulic gradient within the bedrock wells in the southern portion of the Site is relatively steep (as much as 50 ft per 500 ft or 0.1 ft/ft) near the North and South Quarry Landfills, reflecting the effects of ongoing pumping from the landfills. The hydraulic gradient within the alluvial deposit beneath the northern portion of the Site is very flat (approximately 0.5 ft per 1,250 ft or 0.0004 ft/ft). These values are within the range of values reported in the RI (EMSI, 2000). Based on reported average values of 3 x 10⁻² to 3 x 10⁻³ cm/sec (85 to 8.5 ft/day) for the hydraulic conductivity of the alluvium (EMSI, 2000) and a hydraulic gradient of 0.0004 ft/ft, the overall velocity of groundwater flow within the alluvium would be approximately 0.0034 to 0.034 ft/day or 1.2 to 12 ft/year.

Table 4 presents a comparison of the 2012 groundwater levels to groundwater levels measured in 2011 and 1997. These data indicate that water levels within the alluvium were on average approximately one foot higher in 2011 compared to 1997. The 2011 and 2012 water levels within the bedrock monitoring wells were significantly higher than those observed in the same monitoring wells in 1997. An increase in the water level elevations from 1997 to 2011-2012 is consistent with expectations because of groundwater pumping in 1997 for quarry pit operations. By 2011-2012, disposal operations at the Permitted Landfills had ceased. The Permitted Landfills were then in closure mode, which requires much less groundwater pumping to achieve hydraulic control of groundwater and leachate. The water levels in the alluvium observed in

2012 were, on average, close to two feet lower than were observed in 1997 and were on average, two and three-quarters feet lower than were observed in 2011.

The lower water levels observed in 2012 may reflect a drier than average precipitation level for 2012. Table 5 presents the annual precipitation amounts as measured at Lambert St. Louis Airport. Figure 3 presents a graph of these same data. As shown on this figure, although the 2012 precipitation value (through December 9, 2012) was less than the precipitation amounts recorded in the prior four years, the 2012 value is well within the range of precipitation values measured over the last 75 years and does not represent an anomalously dry year.

Fluctuations in groundwater levels are expected given variations in precipitation amounts, evapotranspiration, and patterns and variations in the rates of pumping from the Permitted Landfills. Furthermore, the observed variations in water levels are relatively small considering the comparatively larger saturated thickness (as much as 50 to 100 feet) within the alluvium. Consequently, variations in water level elevations are not expected to significantly affect the representativeness of the groundwater samples.

6. GROUNDWATER SAMPLE RESULTS

This section summarizes the analytical laboratory results for the groundwater samples.

6.1 Radionuclides

The results of the laboratory analyses of the uranium, thorium and radium isotopes are summarized on Tables 6, 7 and 8. Radium was the only radionuclide detected above State or federal water quality or drinking water standards and, as discussed below, most of these results fell within the range of reported background levels of radium. Lucas (1985) reported that "The largest single area in the United States where significant radium concentrations have been reported is within the five-state area that includes Minnesota, Wisconsin, Iowa, Illinois, and Missouri."

6.1.1 Uranium

Uranium is a naturally-occurring element found at low levels in virtually all rock, soil, and water (EPA, 2012a). A study conducted by the U.S. Geological Survey as part of the National Water Quality Assessment Program reported naturally occurring levels of uranium in groundwater in terms of units of mass ranging from non-detect up to as much as 550 ug/L, with a median value of 0.52 ug/L (Ayotte, et. al., 2011).

Table 6 presents a summary of the analytical results of the uranium isotopes. The reported results are presented in units of activity (picocuries per liter or pCi/L) which were converted to units of mass (ug/L) using the procedure defined by EPA (2000). The levels of uranium detected

in the various groundwater monitoring wells were for the most part consistent with naturally-occurring (background) levels of uranium (Ayotte, et al., 2011). None of the calculated total uranium mass concentrations exceed the EPA Maximum Contaminant Level (MCL) of 30 ug/L (Table 6). The highest levels of uranium detected in the Site groundwater were found in monitoring wells completed in the deeper bedrock formations at locations upgradient of OU-1 Radiological Areas 1 and 2. As previously discussed, groundwater within the bedrock in this area discharges to the alluvium. Therefore, the source of uranium occurrences in alluvial groundwater beneath and downgradient of Radiological Areas 1 and 2 is not from leaching from Areas 1 and 2 but reflect natural occurrences of uranium within the alluvial and bedrock groundwater.

6.1.2 Thorium

Thorium is a naturally-occurring radioactive metal found at very low levels in soil, rocks, and water (EPA, 2012b). Table 7 presents a summary of the analytical results of the Site groundwater samples for the thorium isotopes. Overall, only low levels (less than 1 pCi/L) of the thorium isotopes were detected in the majority of the wells. There are no federal or State drinking water or other water quality standards for any of the thorium isotopes or total thorium.

6.1.3 Radium

Radium is a naturally-occurring radioactive metal (EPA, 2012c). Radium is a radionuclide formed by the decay of uranium and thorium in the environment. It occurs at low levels in virtually all rock, soil, water, plants, and animals (EPA, 2012c).

Table 8 summarizes the analytical results for the radium isotopes (Radium-226 and Radium-228) for the 2012 groundwater samples. The occurrences and the activity levels of these isotopes in the Site groundwater samples are consistent with natural occurrences of these isotopes in alluvial and bedrock groundwater in the area. Specifically, the highest reported levels of these isotopes were found in monitoring wells completed in the bedrock formations in areas located upgradient of the OU-1 Radiological Areas 1 and 2. The presence and levels of radium in these wells is consistent with naturally-occurring levels of radium in groundwater in the general area of the Site (see discussion in Section 6.1.3.7 below) as reported in published technical reports (Lucas, 1985 and Szabo, 2012).

Furthermore, most of the groundwater samples contained equal to greater parts of Radium-228 compared to Radium-226. The RIM in OU-1 Radiological Areas 1 and 2 consist primarily of Radium-226 and its parent isotope Thorium-230. With the exception of one sample each from soil borings WL-209 and WL-234 in Area 2, Radium-228 was not detected in any of the OU-1 soil samples at levels above background. Additionally, with the exception of soil borings WL-209 and WL-210, Thorium-232, the parent isotope of Radium-228, also was not detected at levels above background. Furthermore, all of the Thorium-232 and Radium-228 results in the soil samples were significantly lower than the Thorium-230 and Radium-226 results obtained from the same samples. Therefore, based on the overall low levels in groundwater, the fact that

the highest levels in groundwater were found in upgradient bedrock wells, and the general absence of Radium-228 in the source RIM at levels above background, occurrences of Radium-228 in the groundwater reflect natural, background occurrences of this isotope.

6.1.3.1 Radium-226

Radium-226 was reported as being present in 98% of the total fraction (unfiltered) samples and 93% of the dissolved fraction (filtered) samples obtained from the alluvial monitoring wells at the Site (Table 9). The overall average reported level of Radium-226 in the groundwater samples obtained from alluvial monitoring wells was 1.74 pCi/L for the total fraction samples and 1.35 pCi/L for the dissolved fraction samples (Table 9). The median values were 1.29 and 3.38 pCi/L for the total and dissolved fractions, respectively. The highest level of Radium-226 detected in total fraction samples obtained from all of the alluvial wells was 6.84 pCi/L (D-85) (Figure 4). The highest reported level in the dissolved fraction samples was 4.51 pCi/L (PZ-113-AD) (Figure 5).

Radium-226 was reported as being present in 94% of the total fraction samples and 91% of the dissolved fraction samples obtained from the bedrock monitoring wells at the Site (Table 9). The overall average level of Radium-226 in the bedrock groundwater samples was 2.93 pCi/L for the total fraction samples and 3.35 pCi/L for the dissolved fraction samples (Table 9). The median values were 2.16 and 1.94 pCi/L for the total and dissolved fractions, respectively. The highest level of Radium-226 detected in the total fraction samples obtained from the bedrock wells was 12.52 pCi/L in upgradient well PZ-101-SS (Figure 4). The highest reported level in the dissolved fraction samples was 28.87 pCi/L in the same upgradient well (PZ-101-SS) (Figure 5). Well PZ-101-SS is a St. Louis Formation bedrock well located along the south side of the North Quarry Landfill, 500 to 750 feet upgradient from OU-1 Area 1 and approximately 2,000 feet upgradient from Area 2 (Figure 5).

Figures 4 and 5 present the total and dissolved fraction Radium-226 results plotted on the Site base map. Overall these data display a very high degree of spatial variability and do not indicate the presence of contiguous occurrences of Radium-226 indicative of a distinct plume(s) or area(s) of Radium-226 in groundwater. Rather, as can be seen on these figures, occurrences of the highest levels of Radium-226 are present in bedrock monitoring wells located at least 500 feet and in some instances as much as 3,000 feet upgradient of OU-1 Areas 1 and 2.

6.1.3.2 Radium-228

Radium-228 was reported as being present in 74% of the total fraction samples and 64% of the dissolved fraction samples obtained from the alluvial monitoring wells at the Site (Table 9). The overall average reported level of Radium-228 in the groundwater samples obtained from alluvial monitoring wells was 3.57 pCi/L for the total fraction samples and 3.46 pCi/L for the dissolved fraction samples (Table 9). The median values were 3.36 and 3.45 pCi/L for the total and dissolved fractions, respectively. The highest level of Radium-228 detected in the total fraction samples obtained from all of the alluvial wells was 7.71 pCi/L in well PZ-113-AD (Figure 6),

which is upgradient of OU-1 Area 2. The highest reported level in the dissolved fraction samples was 7.70 pCi/L in the same upgradient well (PZ-113-AD) (Figure 7).

Radium-228 was detected in 47% of the total fraction samples and 53% of the dissolved fraction samples obtained from the bedrock monitoring wells at the Site (Table 9). The overall average level of Radium-228 in the bedrock groundwater samples was 2.19 pCi/L for the total fraction samples and 2.11 pCi/L for the dissolved fraction samples (Table 9). The median values were 2.08 and 1.94 pCi/L for the total and dissolved fractions, respectively. The highest level of Radium-228 detected in the total fraction samples obtained from the bedrock wells was 3.68 pCi/L in upgradient well PZ-101-SS. The highest reported level in the dissolved fraction samples was 4.68 pCi/L in upgradient well PZ-104-SD. These wells are located on the south sides of the North and South Quarry Landfills, far upgradient from OU-1 Areas 1 and 2.

Figures 6 and 7 present the total and dissolved fraction Radium-228 results plotted on the Site base map. Overall these data display a very high degree of spatial variability and do not indicate the presence of contiguous occurrences of Radium-228 indicative of a distinct plume(s) or area(s) of Radium-228 in groundwater. Levels of Radium-228 detected in groundwater near or downgradient of OU-1 Areas 1 and 2 are similar to the levels of Radium-228 detected in the bedrock monitoring wells located upgradient of Areas 1 and 2. Further, as discussed above, due to the relative absence of Radium-228 or its source materials in the wastes at the Site, the Radium-228 occurrences in groundwater are considered to be naturally occurring.

6.1.3.3 Combined Radium-226 and -228

Figures 8 and 9 present the combined Radium-226 plus Radium-228 results for the total and dissolved fraction samples, respectively, plotted on the Site base map. The average combined Radium-226 plus Radium-228 for the alluvial monitoring wells was 4.39 pCi/L for the total (unfiltered) fraction samples and 3.73 for the dissolved (filtered) sample fractions (Table 9). The maximum combined radium values detected in the alluvial wells were 13.79 pCi/L (D-85) and 12.20 pCi/L (PZ-113-AD, which is upgradient of OU-1 Area 2) for the total and dissolved fractions, respectively. A total of 28 (61%) of the 46 samples obtained from the alluvial monitoring wells contained combined total fraction (unfiltered samples) Radium-226 plus Radium-228 levels that were above the EPA MCL of 5 pCi/L for radium (Table 8). A total of 29 (64%) of the 45 dissolved fraction samples obtained from the alluvial wells contained combined Radium-226 plus Radium-228 at levels above the MCL (Table 8).

The average combined Radium-226 plus Radium-228 for the bedrock monitoring wells was 4.02 pCi/L for the total (unfiltered) fraction samples and 4.44 pCi/L for the dissolved (filtered) sample fractions (Table 9). The maximum combined radium values detected in bedrock wells were 16.19 and 32.01 pCi/L for the total and dissolved fractions, respectively. Both of these values were detected in bedrock well PZ-101-SS, which is upgradient of OU-1 Areas 1 and 2. A total of 22 (65%) of the 34 samples obtained from the bedrock monitoring wells contained combined total (unfiltered samples) Radium-226 plus Radium-228 levels that were above the MCL of 5 pCi/L for radium (Table 8). A total of 24 (75%) of the 34 dissolved fraction samples obtained

from the bedrock wells contained combined Radium-226 plus Radium-228 at levels above the MCL (Table 8).

6.1.3.4 Duplicate Sample Results for Radium

Eight duplicate samples were collected as part of the field effort (Tables 2, 10 and 11).

Comparison of the duplicate sample results for total Radium-226 is presented on Table 10. When the combined standard uncertainty values of the sample results are considered, the total Radium-226 results obtained from the duplicate samples were generally equivalent to the original samples with the possible exception of the results for the duplicate pair obtained from PZ-113-AD.

The dissolved Radium-226 results obtained from the duplicate samples are also presented on Table 10. When the combined standard uncertainty values of the sample results are considered, the dissolved Radium-226 results obtained from the duplicate samples were generally equivalent to the original samples with the possible exception of the results for the duplicate pair obtained from PZ-113-AD.

The duplicate sample results for total and dissolved Radium-228 are summarized on Table 11. When the combined standard uncertainty values of the sample results are considered, the total and dissolved Radium-228 results obtained from the duplicate samples were generally equivalent to the original samples again with the possible exception of the results for the duplicate pair obtained from PZ-113-AD.

6.1.3.5 Split Sample Results

Both EPA and MDNR obtained splits of some of the groundwater samples. EPA obtained splits of twelve samples and MDNR obtained splits of five samples (Table 2). EPA directed the Respondents to prepare the report without inclusion of EPA's split sample results.

MDNR analyzed its split samples for radionuclides using the same analytical laboratory (Eberline) used by the OU-1 Respondents. MDNR provided a copy of the analytical results for its split samples. Similar to the results obtained for the OU-1 samples, the MDNR split samples only contained trace or non-detectable levels of uranium and thorium isotopes. Those isotopes therefore are not discussed further.

Table 12 presents a comparison of the radium results from the MDNR split samples to the results obtained from the corresponding original OU-1 samples. Considering the combined standard uncertainty values of the sample results, there is generally good agreement between the original and MDNR split samples results for the total and dissolved fractions for both Radium-226 and Radium-228.

6.1.3.6 Comparison to RI/FS Sampling Results

Table 13 presents a summary of the Radium-226 results obtained during the 2012 groundwater sampling event along with the Radium-226 results obtained during the OU-1 RI/FS sampling (McLaren Hart, 1996, and EMSI, 2000 and 2006), and the OU-2 RI/FS sampling (Herst & Associates, 2005). Because the OU-2 RI/FS samples were only analyzed for Radium-226 (the RIM-associated radium isotope), this summary only includes results for Radium-226. Figures 10 and 11 present the total and dissolved Radium-226 results obtained for samples collected during the OU-1 and OU-2 RI/FS investigations. Overall, the locations where Radium-226 was found to be present and the levels of the Radium-226 detected in the 2012 groundwater samples were similar to those identified during the prior RI/FS sampling, especially after consideration of the combined standard uncertainty values associated with the various sample results.

6.1.3.7 Comparison to Published Background Levels of Radium

Missouri generally, and the Site specifically, are located within the Ozark Plateau Cambro-Ordivician (MCOO) aquifer system. Szabo, et al. (2012) found that the median level of combined Radium-226 and Radium-228 in dissolved phase samples obtained from water supply wells (untreated water) in the MCOO aquifer system is 5.9 pCi/L. The maximum reported value for combined Radium-226 and Radium-228 identified in this study was 11.32 pCi/L. The MCOO principal aquifer system had the highest levels of radium of any of the 15 principal aquifers investigated as part of this report (Szabo, et al., 2012).

An earlier study by Lucas (1985), reported that "The largest single area in the United States where significant radium concentrations have been reported is within the five-state area that includes Minnesota, Wisconsin, Iowa, Illinois, and Missouri." It was not uncommon for water supply wells in Missouri to have levels of combined Radium-226 and Radium-228 above 5 and even 10 pCi/L (Lucas, 1985). This earlier work by Lucas (1985) is generally consistent with the findings of Szabo (2012) described above.

The median level of 5.9 pCi/L reported by Szabo et al. (2012) for the MCOO aquifer system is *higher* than the median total concentration of combined Radium-226 and Radium-228 found in either bedrock or alluvial monitoring wells at the Site (Table 9). This indicates that the levels of radium detected in the monitoring wells reflect natural occurrences of radium. The fact that levels of combined radium within the bedrock and alluvial groundwater are so similar is to be expected given that groundwater within the bedrock flows into the alluvial aquifer.

6.2 Trace Metals

The groundwater samples were analyzed for 19 trace metals, exclusive of the major chemistry cations (e.g., calcium, magnesium, sodium and potassium). All of the samples contained non-detectable levels of beryllium, selenium, and silver. Cadmium, copper and thallium were only detected in six to thirteen of the wells. Results obtained for the other thirteen trace metals are summarized on Table 14.

Arsenic was detected in one or both of the sample fractions (total or dissolved) obtained from 31 of the 73 monitoring wells analyzed for trace metals. The majority of the detected results exceed the drinking water standard of 10 ug/L for arsenic. The highest reported arsenic concentrations (170 to 230 ug/L) were found in alluvial wells S-82, PZ-114-AS, PZ-112-AS and PZ-304-AS (Table 14). Results obtained from nearby wells and from wells located adjacent to these wells but screened at deeper intervals contained substantially lower levels of arsenic, indicating that the arsenic occurrences are generally isolated and do not represent a plume or large areas of elevated arsenic concentrations.

The most frequently detected trace metals were iron and manganese which were detected in nearly all of the monitoring wells (Table 14). Nearly all of the iron results exceed the drinking water standard (secondary standard based on aesthetic considerations) of 300 ug/L. The highest levels of iron were found in the total sample fractions obtained from alluvial wells D-85, MW-103, PZ-114-AS, and PZ-302-AS. The dissolved fraction results for wells D-85 and MW-103 contained substantially lower (non-detectable in the case of MW-103) iron concentrations indicating that the majority of the total iron in these wells occurs in the form of suspended sediment.

Nearly all of the manganese results exceed the drinking water standard (secondary standard based on aesthetic considerations) of 50 ug/L. The highest levels of manganese were found in the total (unfiltered) sample fractions obtained from alluvial wells D-85, MW-104, PZ-114-AS, and PZ-305-AI. The dissolved (filtered) fraction results for well D-85 contained a substantially lower manganese concentration indicating that the majority of the total manganese in this well occurs in the form of suspended sediment.

It should be noted that the solubility of arsenic, iron and manganese is largely controlled by their oxidation states, with the reduced form of these metals possessing higher solubility values. Consequently, these metals are commonly detected at solid waste landfills where anaerobic biodegradation of organic matter and decreased infiltration of typically oxygen-rich precipitation (recharge) due to the presence of lower permeability landfill cover results in the creation of reducing conditions. The presence of these trace metals can reflect dissolution of these metals from either the waste materials or dissolution of naturally occurring arsenic, iron and manganese within cover soil material contained in the waste materials or in the soil and bedrock adjacent to the waste deposits.

6.3 Volatile Organic Compounds

Table 15 presents a summary of the primary VOCs that were detected in the groundwater samples. The most commonly detected VOC was benzene, which was reported to be present in 28 of the 74 wells sampled for VOCs. Other VOCs that were detected in the groundwater samples included cis-1,2-dichloroethene (detected in 26 of the samples), chlorobenzene (detected in 24 of the samples), methyl-tert-butyl ether [MTBE] (detected in 22 of the samples), acetone (a common laboratory contaminant reportedly detected in 18 of the samples), 1,1,-dichloroethane (detected in ten of the samples), isopropyl benzene (detected in 11 of the samples), and 1,4-

dichlorobenzene (detected in 13 of the samples). Other VOCs that were detected in the groundwater samples included 1,2,4-trichlorobenzene, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,2-dichloroethane, 2-butanone (aka methyl ethyl ketone or MEK), 2-hexanone, bromomethane, carbon disulfide, chloroform, cyclohexane, dichlorodifluoromethane, ethylbenzene, methylcyclohexane, methylene chloride (a common laboratory contaminant that was also detected in some of the trip blank samples), xylenes, tetrachloroethene, toluene, trans-1,2-dichloroethene, and vinyl chloride, which were detected in one to eight of the 74 groundwater monitoring wells sampled for VOCs. With the exception of two occurrences of chlorobenzene (PZ-112-AS and LR-105) and two occurrences of vinyl chloride (I-9 and I-73), all of these compounds were detected at concentrations less than the Missouri water quality standards.

Benzene was detected in nine monitoring wells at concentrations greater than its water quality standard of 5 ug/L. Occurrences of benzene at concentrations above its water quality standard were found in the southern portion of the Inactive Sanitary Landfill (possibly as a result of a release from an underground storage tank associated with the concrete/asphalt plants, see Herst & Associates, 2005), to the west of OU-1 Area 1 (possibly as a result of historic releases from the underground storage tank located in the northern portion of Area 1), and along the south side of the South Quarry Landfill (likely due to releases from offsite facilities located upgradient of the Site).

6.4 Semi-Volatile Organic Compounds

Only a very few semi-volatile organic compounds (SVOCs) were detected. Detected SVOC results are included on Table 16. The most commonly detected SVOC was 1,4-dichlorobenzene which was detected in 11 of the 73 monitoring wells that were sampled and analyzed for SVOCs. The highest detected concentration of 1,4-dichlorobenzene was 19 ug/L in LR-105, which is less than the Missouri water quality standard of 75 ug/L. The next most frequently detected SVOC was bis (2-ethylhexyl) phthalate which was found to be present in the groundwater samples obtained from nine wells. The highest reported concentration of bis(2-ethylhezyl) phthalate was 120 ug/L in LR-100. The next highest reported concentration of bis(2-ethylhezyl) phthalate was 28 ug/L in PZ-207-AS. These results, along with the results from wells S-5, MW-103, and LR-105, exceeded the Missouri water quality standard of 6 ug/L.

Naphthalene and phenol were each detected in five wells. The highest reported concentration of naphthalene was 220 ug/L in PZ-112-AS. The next highest detected concentration was 56 ug/L in MW-103. These two results are greater than the Missouri water quality standard of 20 ug/L. The other three reported detections of naphthalene were less than the State standard. All five of the detected results for phenol were substantially less than the State standard of 300 ug/L.

Other SVOCs that were detected included 1,2,4-trichlorobenzene, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 2,4-dimethylphenol, 2-chlorophenol, 2-methylnaphthalene, 2-methylphenol, 3 & 4 methylphenol, benzo(b)fluoranthene, butyl benzyl phthalate, dimethyl phthalate, di-n-butyl phthalate, di-n-octyl phthalate, fluoranthene, indeno[1,2,3-cd]pyrene, N-nitrosodiphenylamine, phenanthrene, and pyrene. These chemicals were detected in only one to four of the 73

monitoring wells sampled for SVOCs. With the exception of the single detection of 2-chlorophenol and some of the poly nuclear aromatic hydrocarbons, the results for all of these chemicals were less than the Missouri water quality standards, where established.

7. SUMMARY AND CONCLUSIONS

The results of this sampling event are consistent with past groundwater sampling and support EPA's conclusions in the May 2008 Record of Decision that isolated and sporadic detections of a small number of radiological and conventional contaminants do exist in Site groundwater, but there are no contiguous plumes of radiological or conventional groundwater contamination present underneath the Site or migrating from the Site.

Groundwater flow in the Site area occurs in a generally southeast to northwesterly direction representing the flow of groundwater from the bedrock and terrace deposits upgradient of the Site into the bedrock and alluvial deposits beneath the Site. The hydraulic data indicate that groundwater within the bedrock and alluvium located offsite and beneath the upgradient southern portions of the Site flows into the alluvial deposits located beneath the northwestern two-thirds of the Site, including the areas around OU-1 Radiological Areas 1 and 2.

Review of the analytical results does not indicate that any significant leaching or other contributions of Radium-226 to groundwater are occurring from OU-1 Areas 1 and 2. The levels of radionuclides detected in groundwater beneath and downgradient of the two radiological areas are consistent with the levels of radionuclides detected upgradient of these areas, indicating that the two radiological areas do not contribute radionuclides above background levels. Overall, the highest levels of both total (unfiltered) and dissolved (filtered) Radium-226 were detected in bedrock wells (e.g. PZ-101-SS, PZ-104-SD, PZ-107-SS and PZ-102-SS) located upgradient of OU-1 Areas 1 and 2. The highest levels of Radium-226 in both the total and dissolved fraction samples were found in bedrock wells located anywhere from 500 to as much as 3,000 feet upgradient from OU-1 Areas 1 and 2. This condition indicates that the occurrences of radium isotopes in the groundwater are not the result of leaching from the radiologically-impacted materials in OU-1 Areas 1 and 2, but instead reflect naturally occurring (background) levels of the radium isotopes emanating from the bedrock. The consistency of the Site values with regional background levels of Radium-226 and Radium-228, as reported by Szabo (2012) and Lucas (1985), further supports this conclusion.

The absence of spatial relationship between the RIM occurrences in Areas 1 and 2 and the locations of the highest occurrences of Radium in groundwater indicates that the levels of Radium-226 and Radium-228 found in the area of the Site are of natural origin. Combined radium occurrences above the EPA MCL are found throughout the Site (Figures 8 and 9), including within the bedrock formations and the alluvial deposits upgradient of the two OU-1 areas where RIM is present. In addition, the levels of combined Radium-226 plus Radium-228 measured in the August 2012 groundwater sampling event do not display higher concentrations in the immediate vicinity of OU-1 Areas 1 and 2 or downgradient of Areas 1 and 2.

The highest total and dissolved levels of Radium-228 were detected in alluvial wells located adjacent to OU-1 Areas 1 and 2 (e.g., D-3, D-85, PZ-113-AD but not confirmed by the duplicate sample from this location, and S-61) or the Inactive Sanitary Landfill (e.g., MW-103). Although Radium-228 was found at higher levels in the groundwater samples taken near Areas 1 and 2, the soil data indicate that the Radium-228 does not originate within the RIM in Areas 1 and 2. The analytical results for the soil samples obtained from Areas 1 and 2 indicate that only very low to trace levels of Radium-228 or its parent Thorium-232 are present in the RIM. Furthermore, the occurrence of the highest levels of Radium-228 in the deeper alluvial wells (Figures 6 and 7), rather than in the shallower wells located closer to the RIM, also indicates that an alternate mechanism is responsible for the Radium-228 occurrences in the alluvial groundwater. This information indicates that occurrences of Radium-228 result from the discharge of bedrock groundwater containing Radium-228 to the basal portions of the alluvial aquifer. Consequently the Radium-228 occurrences detected in the groundwater samples represent background conditions.

No contiguous occurrences of radionuclides or chemical constituents indicative of a distinct plume or area of groundwater contamination were found to be present at the Site. In addition to radium generally being located in upgradient bedrock wells, monitoring wells with the highest levels of radium were generally surrounded by monitoring wells with substantially lower levels of radium. No locations with multiple wells displaying higher radium levels or patterns of spatially-correlated increasing or decreasing trends indicative of a source area were identified. Similarly, the groundwater sample results did not indicate the presence of a distinct plume or areas of groundwater impacts of trace metals and VOCs consistent with the observations and conclusions reached during the RI/FS.

The results of the 2012 groundwater sampling event are consistent with and further support the conclusions previously reached regarding Site conditions. The 2012 results generally show sporadic and isolated detections of a small number of contaminants at relatively low concentration levels. These results are not indicative of on-Site contaminant plumes, radial migration, or other forms of contiguous groundwater contamination that might be attributable to the OU-1 Radiological Areas 1 and 2. The groundwater results show no evidence of significant leaching and migration of radionuclides from Areas 1 and 2. Significant leaching and migration of radionuclides or chemicals (e.g., trace metals or VOCs) to perched water or groundwater have not occurred despite landfilled waste materials having been exposed to worst-case leaching conditions from surface water infiltration over a period of decades. The absence of radionuclide contamination in groundwater at the Site is consistent with the relatively low solubility of most radionuclides in water and their affinity to adsorb onto the soil matrix.

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Table 1: Groundwater Level Measurements, July 30, 2012

| Well | Top of Casing (TOC) Elevation (ft. amsl)** | Water Level (ft. below TOC) | Water Level Elevation (ft. amsl) | Notes: |
|------------------------|--|-----------------------------------|---|--|
| | | | | |
| D-3 | 467.92 | 38.11 | 429.81 | |
| D-6 | 447.09 | 18.01 | 429.08 | |
| D-12 | 479.67 | 50.26 | 429.41 | |
| D-13 | 470.53 | 40.90 | 429.63 | |
| D-14 | 483.09 | 30.79 | 452.30 | Measured on 8/7/2012 |
| D-81 | 450.87 | 21.02 | 429.85 | |
| D-83 | 448.55 | 18.99 | 429.56 | |
| D-85 | 457.06 | 27.29 | 429.77 | |
| D-87 | 464.41 | 34.72 | 429.69 | |
| D-93 | 450.76 | 21.34 | 429.42 | I-9 and D-93 may be mis-labeled based on total depths. |
| I-4 | 466.18 | 36.00 | 430.18 | |
| I- 9 | 449.84 | 20.35 | 429.49 | I-9 and D-93 may be mis-labeled based on total depths. |
| I-11 | 480.01 | 50.57 | 429.44 | |
| 1-62 | 446.37 | 16.70 | 429.67 | |
| I-65 | 441.53 | 12.25 | 429.28 | |
| I-66 | 441.87 | 12.20 | 429.67 | |
| 1-67 | 441.78 | 12.18 | 429.60 | |
| 1-68 | 450.39 | 20.63 | 429.76 | |
| I-73 | 461.40 | 28.25 | 433.15 | |
| LR-100 | 468.14 | 17.40 | 450.74 | |
| LR-103 | 470.54 | 40.70 | 429.84 | |
| LR-104 | 459.38 | 29.11 | 430.27 | |
| LR-105 | 485.36 | 31.38 | 453.98 | |
| MW-102 | 447.90 | 18.53 | 429.37 | |
| MW-103 | 437.47 | 9.50 | 427.97 | |
| MW-104 | 440.91 | 11.09 | 429.82 | |
| MW-1204 | 485.53 | 33.20 | 452.33 | |
| PZ-100-KS | 485.61 | 30.41 | 455.20 | |
| PZ-100-SD | 485.72 | 52.93 | 432.79 | |
| PZ-100-SS | 485.75 | 47.50 | 438.25 | |
| PZ-101-SS | 491.26 | 72.73 | 418.53 | |
| PZ-102-SS | 483.90 | 44.80 | 439.10 | |
| PZ-102R-SS | 485.62 | 37.78 | 447.84 | |
| PZ-103-SS | 483.56 | 42.74 | 440.82 | |
| PZ-104-KS | 483.95 | 22.40 | 461.55 | |
| PZ-104-SD | 483.51 | 23.80 | 459.71 | |
| PZ-104-SS | 483.45 | 23.48 | 459.97 | |
| PZ-105-SS | 483.51 | 27.74 | 455.77 | |
| PZ-106-KS | 464.20 | 6.82 | 457.38 | |
| PZ-106-SD | 463.36 | 18.20 | 445.16 | |
| PZ-106-SS | 462.71 | 16.92 | 445.79 | |
| PZ-107-SS | 464.56 | 34.40 | 430.16 | |
| PZ-107-33 PZ-109-SS | 458.55 | 59.91 | 398.64 | |
| PZ-109-33 PZ-110-SS | 461.15 | 33.21 | 427.94 | |
| LT-110-33 | 401.13 | 33.21 | 44/.34 | |

1 of 2 12/14/2012

Table 1: Groundwater Level Measurements, July 30, 2012

| Well | Top of Casing (TOC) Elevation (ft. amsl)** | Water Level (ft. below TOC) | Water Level Elevation (ft. amsl) | Notes: |
|------------------------|---|-----------------------------------|---|--------|
| D7 114 VC | 465.56 | 10.71 | 454.05 | |
| PZ-111-KS | 465.56 | 10.71 | 454.85 | |
| PZ-111-SD | 466.46 | 35.93 | 430.53 | |
| PZ-112-AS | 462.50 | 32.78 | 429.72 | |
| PZ-113-AD | 461.54 | 31.68 | 429.86 | |
| PZ-113-AS | 461.40 | 31.55 | 429.85 | |
| PZ-113-SS | 461.77 | 31.85 | 429.92 | |
| PZ-114-AS | 451.26 | 21.35 | 429.91 | |
| PZ-115-SS | 452.27 | 36.93 | 415.34 | |
| PZ-116-SS | 484.85 | 31.80 | 453.05 | |
| PZ-200-SS | 485.57 | 45.58 | 439.99 | |
| PZ-201A-SS | 480.20 | 33.55 17.70 | 446.65 | |
| PZ-202-SS PZ-203-SS | 481.02 | 17.78 27.80 | 463.24 | |
| | 486.44 | | 458.64 | |
| PZ-204A-SS | 462.60 | 7.31 | 455.29 451.04 | |
| PZ-204-SS | 464.79 450.05 | 12.85 | 451.94 430.67 | |
| PZ-205-AS | 459.95 461.73 | 30.28 | 429.67 430.22 | |
| PZ-205-SS | 461.73 | 31.51 | | |
| PZ-206-SS | 460.29 | 34.70 | 425.59 | |
| PZ-207-AS | 462.49 | 32.75 | 429.74 | |
| PZ-208-SS PZ-302-AI | 474.19 450.17 | 26.01 21.22 | 448.18 428.95 | |
| PZ-302-A1 PZ-302-AS | 450.17 | 21.22 | 430.05 | |
| | | 23.42 | 430.03 | |
| PZ-303-AS PZ-304-AI | 453.08 453.86 | 23.42 24.19 | 429.67 | |
| PZ-304-AI PZ-304-AS | 453.61 | 23.90 | 429.71 | |
| PZ-304-A3 PZ-305-AI | 459.83 | 29.60 | 430.23 | |
| S-5 | 459.85 466.45 | 36.01 | 430.23 | |
| S-8 | 443.83 | 14.49 | 429.34 | |
| S-10 | 480.06 | 50.54 | 429.52 | |
| S-53 | 444.18 | 30.34 14.27 | 429.52 429.91 | |
| 5-55 S-61 | 444.16 449.52 | 20.17 | 429.35 | |
| S-82 | 449.52 449.94 | 20.17 | 429.35 429.46 | |
| 5-82 S-84 | 449.94 456.78 | 20.48 26.98 | 429.46 | |
| 3-04 | 430.76 | 20.30 | 423.00 | |

^{**} Survey data provided by Aquaterra in a spreadsheet dated 9/14/2012. amsl = above mean sea level

2 of 2 12/14/2012

Table 2: Wells Sampled During the Additional OU-1 Groundwater Monitoring Effort

| Well | Well | Duplicate Samples | _ |
|------------|------------------|--------------------------|----------------------------|
| PZ-100-SS | LR-100 | DUP-01 PZ-201A-SS | |
| PZ-100-SD | LR-103 | DUP-02 PZ-200-SS | |
| PZ-100-KS | LR-104 | DUP-03 PZ-113-AD | |
| PZ-101-SS | LR-105 | DUP-04 D-6 | |
| PZ-102-SS | | DUP-05 D-3 | |
| PZ-102R-SS | MW-102 | DUP-06 D-13 | |
| PZ-103-SS | MW-103 | DUP-07 LR-104 | |
| PZ-104-SS | MW-104 | DUP-08 I-9 | |
| PZ-104-SD | MW-1204 | | |
| PZ-104-KS | | | |
| PZ-105-SS | S-5 | EPA Split Samples | _ |
| PZ-106-SS | S-8 | PZ-101-SS | - |
| PZ-106-SD | S-10 | PZ-112-AS | |
| PZ-106-KS | S-61 | PZ-113-AS | |
| PZ-107-SS | S-82 | PZ-206-SS | |
| PZ-109-SS | S-84 | PZ-207-AS | |
| PZ-110-SS | | PZ-305-AI | |
| PZ-111-SD | 1-4 | MW-102 | |
| PZ-111-KS | I-9 | S-61 | |
| PZ-112-AS | I-11 | I-11 | |
| PZ-113-AS | I-62 | D-3 | |
| PZ-113-AD | 1-65 | D-6 | |
| PZ-113-SS | 1-66 | D-6 duplicate | |
| PZ-114-AS | 1-67 | D-12 | |
| PZ-115-SS | 1-68 | | |
| PZ-116-SS | 1-73 | | |
| PZ-200-SS | | MDNR Split Samples | _ |
| PZ-201A-SS | D-3 | PZ-106-KS | _ |
| PZ-202-SS | D-6 | S-5 | |
| PZ-203-SS | D-12 | 1-4 | |
| PZ-204-SS | D-13 | I-9 | |
| PZ-204A-SS | D-14 | D-93 | |
| PZ-205-AS | D-81 | | |
| PZ-205-SS | D-83 | | |
| PZ-206-SS | D-85 | Well Legend | |
| PZ-207-AS | D-87 | S prefix or AS suffix | Shallow alluvial well |
| PZ-208-SS | D-93 | I prefix or AI suffix | Intermediate alluvial well |
| PZ-302-AI | | D prefix or AD suffix | Deep intermediate well |
| PZ-303-AS | | SS suffix | St. Louis Fm. bedrock well |
| PZ-304-AS | Total = 75 wells | SD suffix | Salem Fm. bedrock well |
| PZ-304-AI | | KS suffix | Keokuk Fm. Bedrock well |
| PZ-305-AI | | | |

Table 3: Vertical Groundwater Gradients, July 30, 2012

| | Water | | | Midpoint Elevation of | | Difference in Screen | |
|---------------|-------------|------------------|--------------------|--------------------------|------------|----------------------|----------|
| | Level | Original Top of | Original Bottom of | Screen | Head | Midpoint | Vertical |
| | Elevation | Screen Elevation | Screen Elevation | Interval | Difference | Elevations | Gradient |
| Well | (ft amsl) | (ft amsl) | (ft amsl) | (ft amsl) | (ft) | (ft) | (ft/ft) |
| Alluvial Well | Clusters | | | | | | |
| S-5 | 430.44 | 435.70 | 425.70 | 430.70 | 0.26 | 36.20 | 0.0072 |
| I-4 | 430.18 | 399.50 | 389.50 | 394.50 | 0.37 | 28.80 | 0.0128 |
| D-3 | 429.81 | 370.70 | 360.70 | 365.70 | 0.63 | 65.00 | 0.0097 |
| MW-102 | 429.37 | 432.18 | 422.18 | 427.18 | 0.29 | 84.28 | 0.0034 |
| D-6 | 429.08 | 347.90 | 337.90 | 342.90 | | | |
| S-10 | 429.52 | 445.50 | 425.50 | 435.50 | 0.08 | 43.40 | 0.0018 |
| I-11 | 429.44 | 397.10 | 387.10 | 392.10 | 0.03 | 53.40 | 0.0006 |
| D-12 | 429.41 | 343.70 | 333.70 | 338.70 | 0.11 | 96.80 | 0.0011 |
| S-8 | 429.34 | 434.80 | 414.80 | 424.80 | -0.33 | 19.70 | -0.0168 |
| 1-62 | 429.67 | 410.10 | 400.10 | 405.10 | 0.11 | 231.40 | 0.0005 |
| D-83 | 429.56 | 0.00 | 347.40 | 173.70 | -0.22 | 251.10 | -0.0009 |
| S-84 | 429.80 | 432.00 | 422.00 | 427.00 | 0.03 | 241.45 | 0.0001 |
| D-85 | 429.77 | 0.00 | 371.10 | 185.55 | | | |
| S-82 | 429.46 | 0.00 | 422.20 | 211.10 | -0.03 | -189.30 | 0.0002 |
| I-9 | 429.49 | 405.40 | 395.40 | 400.40 | 0.07 | 29.70 | 0.0024 |
| D-93 | 429.42 | 380.70 | 360.70 | 370.70 | 0.04 | -159.60 | -0.0003 |
| PZ-302-AS | 430.05 | -408.77 | 427.50 | 9.37 | 1.10 | 9.43 | 0.1166 |
| PZ-302-AI | 428.95 | -407.73 | 407.60 | -0.06 | | | |
| PZ-304-AI | 429.67 | 412.60 | 402.80 | 407.70 | -0.04 | -21.70 | 0.0018 |
| PZ-304-AS | 429.71 | 434.30 | 424.50 | 429.40 | | | |
| Alluvial and | Bedrock Wel | ll Clusters | | | | | |
| PZ-113-AS | 429.85 | 431.00 | 421.20 | 426.10 | -0.01 | 69.70 | -0.0001 |
| PZ-113-AD | 429.86 | 361.30 | 351.50 | 356.40 | -0.06 | 49.87 | -0.0012 |
| PZ-113-SS | 429.92 | 311.43 | 301.63 | 306.53 | -0.07 | 119.57 | -0.0006 |
| PZ-205-AS | 429.67 | 420.75 | 410.95 | 415.85 | -0.55 | 49.82 | -0.0110 |
| PZ-205-SS | 430.22 | 370.93 | 361.13 | 366.03 | | | |

Notes: Positve values for vertical gradient indicate a downward gradient whereas negative values indicate an upward gradient.

Table 4: Comparison of 2012, 2011 and 1997 Groundwater Levels

| Monitoring point | August/ November 1997 | December 2011 | July 30, 2012 | 2011 - 1997 Difference (ft) | 2012 - 1997 Difference (ft) | 2012 - 2011 Difference (ft) |
|------------------|-----------------------------|------------------|---------------|--------------------------------|--------------------------------|--------------------------------|
| | | · · - | | | | |
| Allvuial Wells | | | | | | |
| S-5 | 432.27 | 434.81 | 430.44 | 2.54 | -1.83 | -4.37 |
| S-84 | 431.47 | 430.92 | 429.80 | -0.55 | -1.67 | -1.12 |
| I-4 | 432.11 | 434.56 | 430.18 | 2.45 | -1.93 | -4.38 |
| I-68 | 432.31 | 430.25 | 429.76 | -2.06 | -2.55 | -0.49 |
| I-73 | 431.89 | 437.48 | 433.15 | 5.59 | 1.26 | -4.33 |
| D-3 | 432 | 434.57 | 429.81 | 2.57 | -2.19 | -4.76 |
| D-85 | 432.13 | 434.56 | 429.77 | 2.43 | -2.36 | -4.79 |
| LR-104 | 431.89 | 432.59 | 430.27 | 0.7 | -1.62 | -2.32 |
| PZ-112-AS | 431.83 | 429.6 | 429.72 | -2.23 | -2.11 | 0.12 |
| PZ-113-AS | 431.82 | 432.24 | 429.85 | 0.42 | -1.97 | -2.39 |
| PZ-113-SS | 431.42 | 432.29 | 429.92 | 0.87 | -1.5 | -2.37 |
| PZ-114-AS | 432.42 | 432.37 | 429.91 | -0.05 | -2.51 | -2.46 |
| PZ-205-AS | 431.81 | 432.24 | 429.67 | 0.43 | -2.14 | -2.57 |
| PZ-207-AS | 431.97 | 433.36 | 429.74 | 1.39 | -2.23 | -3.62 |
| PZ-305-AI | 431.88 | 431.67 | 430.23 | -0.21 | -1.65 | -1.44 |
| | | Average differ | rence | 0.95 | -1.80 | -2.75 |
| Bedrock Wells | | | | | | |
| PZ-115-SS | 419.23 | 405.4 | 415.34 | -13.83 | -3.89 | 9.94 |
| PZ-116-SS | 396.03 | 445.66 | 453.05 | 49.63 | 57.02 | 7.39 |
| PZ-100-KS | 442.65 | 449.85 | 455.20 | 7.2 | 12.55 | 5.35 |
| PZ-100-SD | 384.77 | 410.63 | 432.79 | 25.86 | 48.02 | 22.16 |
| PZ-100-SS | 413.28 | 418.31 | 438.25 | 5.03 | 24.97 | 19.94 |
| PZ-101-SS | 391.62 | 386.56 | 418.53 | -5.06 | 26.91 | 31.97 |
| PZ-102R-SS | 401.07 | 439.67 | 447.84 | 38.6 | 46.77 | 8.17 |
| PZ-103-SS | 379.65 | 415.27 | 440.82 | 35.62 | 61.17 | 25.55 |
| PZ-104-KS | 449.62 | 460.04 | 461.55 | 10.42 | 11.93 | 1.51 |
| PZ-104-SD | 399.64 | 454.29 | 459.71 | 54.65 | 60.07 | 5.42 |
| PZ-104-SS | 395.94 | 450.83 | 459.97 | 54.89 | 64.03 | 9.14 |
| PZ-105-SS | 398.45 | 450.79 | 455.77 | 52.34 | 57.32 | 4.98 |
| PZ-106-KS | 446.98 | 455.77 | 457.38 | 8.79 | 10.4 | 1.61 |
| PZ-106-SD | 388.07 | 434.61 | 445.16 | 46.54 | 57.09 | 10.55 |
| PZ-106-SS | 389.64 | 435.73 | 445.79 | 46.09 | 56.15 | 10.06 |
| PZ-107-SS | 431.12 | 432.18 | 430.16 | 1.06 | -0.96 | -2.02 |
| PZ-109-SS | 380.78 | 375.53 | 398.64 | -5.25 | 17.86 | 23.11 |
| PZ-110-SS | 411.39 | 427.04 | 427.94 | 15.65 | 16.55 | 0.9 |
| PZ-200-SS | 412.08 | 419.81 | 439.99 | 7.73 | 27.91 | 20.18 |
| PZ-201A-SS | 413.95 | 432.19 | 446.65 | 18.24 | 32.7 | 14.46 |
| PZ-202-SS | 449.63 | 460.65 | 463.24 | 11.02 | 13.61 | 2.59 |
| PZ-203-SS | 400.35 | 454.13 | 458.64 | 53.78 | 58.29 | 4.51 |
| PZ-204A-SS | 404.8 | 459.41 | 455.29 | 54.61 | 50.49 | -4.12 |
| PZ-205-SS | 421.98 | 428.28 | 430.22 | 6.3 | 8.24 | 1.94 |
| PZ-208-SS | 431.69 | 445.19 | 448.18 | 13.5 | 16.49 | 2.99 |
| | | Average diffe | rence | 23.7 | 33.3 | 9.5 |

Table 5: Annual Precipitation - St Louis Lambert Field

| Year | Total Precipitation (inches)* | _ | Year | Total Precipitation (inches)* |
|------|-------------------------------|---|------|-------------------------------|
| 4007 | | _ | 1075 | |
| 1937 | 36.85 | | 1975 | 40.21 |
| 1938 | 37.49 | | 1976 | 23.46 |
| 1939 | 36.56 | | 1977 | 43.41 |
| 1940 | 24.73 | | 1978 | 37.71 |
| 1941 | 31.37 | | 1979 | 29.48 |
| 1942 | 41.64 | | 1980 | 27.48 |
| 1943 | 37.53 | | 1981 | 45.52 |
| 1944 | 34.90 | | 1982 | 54.97 |
| 1945 | 47.55 | | 1983 | 44.80 |
| 1946 | 50.31 | | 1984 | 51.65 |
| 1947 | 35.78 | | 1985 | 50.73 |
| 1948 | 42.26 | | 1986 | 34.88 |
| 1949 | 45.68 | | 1987 | 38.38 |
| 1950 | 37.63 | | 1988 | 33.93 |
| 1951 | 36.37 | | 1989 | 28.60 |
| 1952 | 25.67 | | 1990 | 45.09 |
| 1953 | 20.69 | | 1991 | 33.48 |
| 1954 | 27.61 | | 1992 | 33.49 |
| 1955 | 31.33 | | 1993 | 54.76 |
| 1956 | 34.43 | | 1994 | 34.70 |
| 1957 | 47.16 | | 1995 | 41.68 |
| 1958 | 37.38 | | 1996 | 43.67 |
| 1959 | 28.31 | | 1997 | 31.23 |
| 1960 | 31.78 | | 1998 | 43.62 |
| 1961 | 41.20 | | 1999 | 34.06 |
| 1962 | 34.63 | | 2000 | 37.37 |
| 1963 | 28.62 | | 2001 | 35.29 |
| 1964 | 32.16 | | 2002 | 40.95 |
| 1965 | 28.26 | | 2003 | 46.06 |
| 1966 | 32.34 | | 2004 | 42.27 |
| 1967 | 41.30 | | 2005 | 37.85 |
| 1968 | 32.49 | | 2006 | 29.93 |
| 1969 | 43.72 | | 2007 | 30.57 |
| 1970 | 36.20 | | 2008 | 57.96 |
| 1971 | 33.73 | | 2009 | 50.92 |
| 1972 | 33.74 | | 2010 | 39.07 |
| 1973 | 39.82 | | 2011 | 47.17 |
| 1974 | 36.83 | | 2012 | 33.9 |

Notes:

2012 total is through December 9, 2012

^{*}Data collected at St Louis Lambert Field

Table 6: Summary of Uranium Results from OU-1 Additional Groundwater Sampling

| | | | Uraniu | m-234 | | | Uraniu | m-235 | | | Uraniu | m-238 | | TOTA | L | |
|--------------|-----------|--------|--------|-------|-------|--------|--------|-------|-------|--------|--------|-------|-------|-------|---|---------|
| | | | | | | | | | | | | | | U-234 | | Total |
| | Sample | | | | FINAL | | | | FINAL | | | | FINAL | U-235 | | Uranium |
| Sample ID | Date | Result | CSU | MDA | Q | Result | CSU | MDA | Q | Result | CSU | MDA | Q | U-238 | 3 | (ug/l) |
| S-5 DIS | 8/14/2012 | 0.29 | 0.32 | 0.43 | UJ | 0.09 | 0.25 | 0.53 | UJ | 0.11 | 0.21 | 0.37 | IJ | ND | * | 1.36 |
| S-8 DIS | 8/9/2012 | 0.79 | 0.33 | 0.22 | | 0.29 | 0.22 | 0.17 | J | 0.74 | 0.32 | 0.18 | | 1.82 | | 2.33 |
| S-10 DIS | 8/8/2012 | 0.73 | 0.37 | 0.21 | J | 0.16 | 0.21 | 0.32 | UJ | 0.78 | 0.39 | 0.26 | J | 1.51 | * | 2.49 |
| S-61 DIS | 8/7/2012 | 1.32 | 0.44 | 0.16 | | 0.22 | 0.19 | 0.16 | J | 0.86 | 0.35 | 0.19 | | 2.40 | | 2.68 |
| S-82 DIS | 8/10/2012 | 0.34 | 0.30 | 0.32 | J | 0.04 | 0.16 | 0.40 | UJ | 0.17 | 0.21 | 0.27 | UJ | 0.34 | * | 1.00 |
| S-84 DIS | 8/6/2012 | 0.09 | 0.11 | 0.13 | U | -0.01 | 0.08 | 0.19 | U | 0.01 | 0.07 | 0.18 | U | ND | | 0.63 |
| I-4 DIS | 8/14/2012 | 0.12 | 0.34 | 0.73 | UJ | 0.00 | 0.42 | 0.90 | UJ | 0.00 | 0.34 | 0.73 | UJ | ND | | 2.59 |
| I-9 DIS | 8/14/2012 | 0.37 | 0.29 | 0.24 | J | 0.00 | 0.19 | 0.40 | UJ | 0.00 | 0.15 | 0.33 | נט | 0.37 | * | 1.16 |
| I-9 DUP DIS | 8/14/2012 | 0.32 | 0.24 | 0.19 | J | -0.04 | 0.11 | 0.30 | UJ | 0.02 | 0.09 | 0.22 | υJ | 0.32 | * | 0.78 |
| I-11 DIS | 8/8/2012 | 0.58 | 0.31 | 0.18 | J | 0.04 | 0.10 | 0.22 | U | 0.73 | 0.35 | 0.17 | | 1.31 | * | 2.28 |
| I-62 DIS | 8/9/2012 | 0.31 | 0.20 | 0.19 | J | 0.13 | 0.14 | 0.16 | U | 0.19 | 0.15 | 0.13 | J | 0.50 | * | 0.65 |
| 1-65 DIS | 8/6/2012 | 0.82 | 0.30 | 0.18 | J | 0.05 | 0.08 | 0.14 | UJ | 0.71 | 0.28 | 0.16 | J | 1.53 | * | 2.18 |
| 1-66 DIS | 8/10/2012 | 0.71 | 0.28 | 0.15 | J | 0.06 | 0.09 | 0.14 | UJ | 0.29 | 0.18 | 0.15 | J | 1.00 | * | 0.92 |
| I-67 DIS | 8/10/2012 | 0.75 | 0.31 | 0.17 | J | 0.00 | 0.10 | 0.21 | UJ | 0.82 | 0.32 | 0.15 | J | 1.57 | * | 2.53 |
| 1-68 DIS | 8/6/2012 | 1.24 | 0.46 | 0.20 | | 0.19 | 0.20 | 0.25 | U | 0.89 | 0.38 | 0.24 | | 2.13 | * | 2.77 |
| 1-73 DIS | 8/4/2012 | 1.32 | 0.45 | 0.14 | | 0.02 | 0.08 | 0.21 | U | 0.76 | 0.33 | 0.15 | | 2.08 | * | 2.37 |
| D-3 DIS | 8/8/2012 | 0.08 | 0.14 | 0.26 | UJ | 0.03 | 0.13 | 0.32 | UJ | 0.14 | 0.17 | 0.22 | UJ | ND | | 0.80 |
| D-3 DUP DIS | 8/8/2012 | 0.17 | 0.17 | 0.20 | UJ | -0.01 | 0.09 | 0.19 | UJ | 0.07 | 0.10 | 0.15 | υJ | ND | | 0.55 |
| D-6 DIS | 8/7/2012 | 0.25 | 0.22 | 0.26 | U | 0.03 | 0.10 | 0.24 | U | 0.05 | 0.21 | 0.43 | U | ND | | 1.39 |
| D-6 DUP DIS | 8/7/2012 | 0.33 | 0.22 | 0.20 | J | 0.11 | 0.14 | 0.18 | U | 0.14 | 0.15 | 0.19 | U | 0.33 | * | 0.66 |
| D-12 DIS | 8/8/2012 | 0.12 | 0.16 | 0.23 | U | -0.02 | 0.10 | 0.25 | U | 0.21 | 0.19 | 0.20 | J | 0.21 | * | 0.75 |
| D-13 DIS | 8/10/2012 | 0.27 | 0.23 | 0.24 | J | 0.10 | 0.18 | 0.31 | UJ | -0.01 | 0.08 | 0.19 | UJ | 0.27 | * | 0.71 |
| D-13 DUP DIS | 8/10/2012 | 0.11 | 0.15 | 0.22 | UJ | 0.08 | 0.15 | 0.27 | UJ | 0.07 | 0.12 | 0.19 | UJ | ND | | 0.68 |
| D-81 DIS | 8/9/2012 | 1.67 | 0.49 | 0.15 | J | 0.33 | 0.23 | 0.22 | J | 1.22 | 0.41 | 0.15 | J | 3.21 | | 3.78 |
| D-83 DIS | 8/9/2012 | 0.05 | 0.18 | 0.40 | UJ | 0.15 | 0.25 | 0.44 | UJ | -0.08 | 0.13 | 0.42 | UJ | ND | | 1.45 |
| D-85 DIS | 8/6/2012 | 0.16 | 0.14 | 0.17 | UJ | 0.07 | 0.10 | 0.15 | IJ | 0.03 | 0.08 | 0.17 | UJ | ND | | 0.59 |

Table 6: Summary of Uranium Results from OU-1 Additional Groundwater Sampling

| | | | Uraniu | m-234 | | | Uraniu | m-235 | | | Uraniu | m-238 | | ТОТА | | |
|-------------------|-----------|--------|--------|-------|---------------|------------|--------|-------|---------------|--------|--------|-------|--------|-------|---|---------|
| | | | | | 511141 | | | | 513141 | | | | 513141 | U-234 | | Total |
| | Sample | | | | FINAL | . . | | | FINAL | | 0011 | | FINAL | U-235 | | Uranium |
| Sample ID | Date | Result | CSU | MDA | Q | Result | CSU | MDA | Q | Result | CSU | MDA | Q | U-238 | | (ug/l) |
| D-87 DIS | 8/1/2012 | 0.11 | 0.16 | 0.24 | UJ | -0.01 | 0.11 | 0.23 | UJ+ | 0.08 | 0.13 | 0.19 | IJ | ND | | 0.66 |
| D-93 DIS | 8/14/2012 | 0.21 | 0.20 | 0.25 | UJ | 0.05 | 0.14 | 0.31 | UJ | 0.16 | 0.17 | 0.19 | U | ND | | 0.70 |
| LR-100 DIS | 8/13/2012 | 0.10 | 0.17 | 0.30 | UJ | -0.03 | 0.12 | 0.30 | UJ | -0.04 | 0.11 | 0.36 | UJ | ND | | 1.22 |
| LR-103 DIS | 8/13/2012 | 0.30 | 0.24 | 0.20 | J | 0.10 | 0.16 | 0.25 | UJ | 0.11 | 0.16 | 0.23 | UJ | 0.30 | * | 0.81 |
| LR-104 DIS | 8/13/2012 | 2.14 | 0.78 | 0.35 | J | 0.84 | 0.51 | 0.43 | J | 2.21 | 0.79 | 0.29 | J | 5.19 | | 6.99 |
| LR-104 DUP DIS | 8/13/2012 | 2.88 | 0.85 | 0.24 | J | 0.48 | 0.34 | 0.30 | J | 2.14 | 0.70 | 0.21 | J | 5.51 | | 6.61 |
| LR-105 DIS | 8/1/2012 | 0.02 | 0.14 | 0.38 | UJ | -0.06 | 0.17 | 0.47 | UJ+ | -0.01 | 0.15 | 0.45 | UJ | ND | | 1.55 |
| MW-102 DIS | 8/7/2012 | 2.14 | 0.59 | 0.21 | J | 0.12 | 0.15 | 0.23 | U | 1.85 | 0.55 | 0.29 | | 3.99 | * | 5.62 |
| MW-103 DIS | 8/11/2012 | 5.20 | 1.11 | 0.21 | | 0.17 | 0.19 | 0.26 | U | 3.12 | 0.78 | 0.18 | | 8.32 | * | 9.42 |
| MW-104 DIS | 8/9/2012 | 0.46 | 0.33 | 0.32 | j | 0.12 | 0.19 | 0.30 | UJ | 0.32 | 0.27 | 0.25 | J | 0.77 | * | 1.08 |
| MW-1204 DIS | 8/2/2012 | 0.15 | 0.16 | 0.22 | UJ | 0.10 | 0.12 | 0.17 | UJ | 0.11 | 0.13 | 0.19 | UJ | ND | | 0.65 |
| PZ-100-KS DIS | 8/16/2012 | 0.05 | 0.15 | 0.32 | IJ | -0.04 | 0.13 | 0.36 | UJ | 0.03 | 0.11 | 0.27 | UJ | ND | | 0.96 |
| PZ-100-SD DIS | 7/31/2012 | 0.27 | 0.19 | 0.17 | J | 0.03 | 0.08 | 0.16 | U | 0.38 | 0.22 | 0.13 | J | 0.65 | * | 1.20 |
| PZ-100-SS DIS | 7/31/2012 | 5.41 | 1.12 | 0.20 | | 0.16 | 0.18 | 0.24 | U | 2.05 | 0.58 | 0.14 | | 7.46 | * | 6.22 |
| PZ-101-SS DIS | 8/7/2012 | 1.33 | 0.93 | 0.74 | J | 0.14 | 0.35 | 0.72 | IJ | 1.35 | 0.93 | 0.67 | J | 2.68 | * | 4.35 |
| PZ-102R-SS DIS | 8/13/2012 | 4.61 | 0.92 | 0.12 | J | 0.33 | 0.21 | 0.15 | J | 3.69 | 0.78 | 0.12 | J | 8.63 | | 11.16 |
| PZ-102-SS DIS | 8/13/2012 | 3.35 | 0.75 | 0.15 | | 0.49 | 0.27 | 0.21 | J | 2.10 | 0.55 | 0.15 | J | 5.93 | | 6.47 |
| PZ-103-SS DIS | 8/7/2012 | 0.11 | 0.11 | 0.13 | UJ | 0.08 | 0.10 | 0.13 | UJ . | 0.09 | 0.10 | 0.10 | UJ | ND | | 0.36 |
| PZ-104-KS DIS | 8/13/2012 | 0.21 | 0.17 | 0.18 | J | 0.04 | 0.10 | 0.22 | U | 0.11 | 0.12 | 0.14 | UJ | 0.21 | * | 0.51 |
| PZ-104-SD DIS | 8/1/2012 | 1.02 | 0.95 | 0.98 | J | -0.04 | 0.46 | 0.96 | UJ | 0.15 | 0.37 | 0.78 | UJ | 1.02 | * | 2.76 |
| PZ-104-SS DIS | 8/1/2012 | 0.91 | 0.31 | 0.15 | J | 0.07 | 0.10 | 0.13 | UJ | 0.50 | 0.22 | 0.12 | J | 1.41 | * | 1.56 |
| PZ-105-SS DIS | 8/1/2012 | 3.06 | 0.70 | 0.19 | | 0.19 | 0.16 | 0.16 | J+ | 1.88 | 0.51 | 0.14 | | 5.14 | | 5.70 |
| PZ-106-KS DIS | 8/14/2012 | 2.34 | 0.65 | 0.20 | | 0.12 | 0.15 | 0.19 | U | 0.83 | 0.36 | 0.20 | | 3.17 | * | 2.56 |
| PZ-106-SD DIS | 7/31/2012 | 0.12 | 0.13 | 0.18 | IJ | 0.02 | 0.07 | 0.17 | UJ | 0.05 | 0.08 | 0.14 | UJ | ND | | 0.50 |
| PZ-106-SS DIS | 7/31/2012 | 1.14 | 0.45 | 0.18 | J | 0.00 | 0.13 | 0.28 | UJ | 0.57 | 0.31 | 0.23 | J | 1.72 | * | 1.84 |
| PZ-107-SS DIS | 8/4/2012 | 1.88 | 0.53 | 0.18 | | 0.13 | 0.15 | 0.19 | U | 1.37 | 0.44 | 0.17 | | 3.25 | * | 4.18 |

Table 6: Summary of Uranium Results from OU-1 Additional Groundwater Sampling

| | | | Uraniu | m-234 | | | Uraniu | m-235 | | 1 | Uraniu | m-238 | | TOTA | L | |
|--------------------|-----------|--------|--------|-------|-------|--------|--------|-------|-------|--------|--------|-------|-------|-------|----------|---------|
| | | | | | | | | | | | | | | U-234 | | Total |
| | Sample | | | | FINAL | | | | FINAL | | | | FINAL | U-235 | + | Uranium |
| Sample ID | Date | Result | CSU | MDA | Q | Result | CSU | MDA | Q | Result | CSU | MDA | Q | U-238 | <u> </u> | (ug/l) |
| PZ-109-SS DIS | 8/2/2012 | 1.43 | 0.57 | 0.23 | J | 0.06 | 0.17 | 0.36 | UJ | 0.96 | 0.46 | 0.29 | J | 2.39 | * | 3.03 |
| PZ-110-SS DIS | 8/2/2012 | 0.18 | 0.17 | 0.21 | U | -0.01 | 0.09 | 0.21 | U | -0.01 | 0.07 | 0.17 | U | ND | | 0.60 |
| PZ-111-K3 DIS | 8/13/2012 | 8.33 | 1.63 | 0.17 | | 0.74 | 0.39 | 0.28 | J | 2.80 | 0.75 | 0.17 | J | 11.87 | | 8.68 |
| PZ-111-SD DIS | 8/1/2012 | 0.32 | 0.20 | 0.16 | J | 0.06 | 0.10 | 0.15 | UJ+ | 0.34 | 0.21 | 0.17 | J | 0.67 | * | 1.09 |
| PZ-112-AS DIS | 8/8/2012 | 0.03 | 0.10 | 0.21 | UJ | 0.04 | 0.12 | 0.25 | U | -0.02 | 0.07 | 0.18 | U | ND | | 0.65 |
| PZ-113 AD DUP DIS | 8/3/2012 | 1.36 | 0.61 | 0.39 | J | 0.62 | 0.43 | 0.34 | J | 0.31 | 0.28 | 0.30 | J | 2.29 | | 1.22 |
| PZ-113-AD DIS | 8/3/2012 | -0.03 | 0.12 | 0.31 | UJ | 0.06 | 0.14 | 0.30 | UJ | -0.01 | 0.12 | 0.24 | υJ | ND | | 0.87 |
| PZ-113-AS DIS | 8/8/2012 | 1.02 | 0.51 | 0.32 | J | -0.03 | 0.14 | 0.36 | UJ | 0.71 | 0.41 | 0.25 | J | 1.73 | * | 2.28 |
| PZ-113-SS DIS | 8/4/2012 | 1.57 | 0.46 | 0.18 | J | 0.18 | 0.17 | 0.20 | UJ | 0.84 | 0.32 | 0.14 | J | 2.41 | * | 2.60 |
| PZ-114-AS DIS | 7/31/2012 | 0.19 | 0.18 | 0.20 | UJ | 0.05 | 0.14 | 0.30 | UJ | 0.07 | 0.14 | 0.27 | υJ | ND | | 0.94 |
| PZ-115-SS DIS | 7/31/2012 | 1.90 | 0.62 | 0.20 | | 0.10 | 0.17 | 0.30 | U | 1.26 | 0.49 | 0.24 | | 3.16 | * | 3.89 |
| PZ-116-SS DIS | 8/3/2012 | 6.40 | 1.26 | 0.17 | | 1.25 | 0.48 | 0.17 | | 2.20 | 0.61 | 0.21 | | 9.85 | | 7.12 |
| PZ-200 SS DUP DIS | 8/2/2012 | 0.69 | 0.33 | 0.20 | | 0.12 | 0.15 | 0.18 | U | 0.22 | 0.19 | 0.21 | J | 0.91 | * | 0.74 |
| PZ-200-SS DIS | 8/2/2012 | 0.18 | 0.17 | 0.22 | U | 0.01 | 0.08 | 0.22 | U | 0.55 | 0.28 | 0.18 | J | 0.55 | * | 1.76 |
| PZ-201A-SS DIS | 8/1/2012 | 1.96 | 0.49 | 0.10 | J | 0.01 | 0.06 | 0.15 | UJ+ | 1.16 | 0.35 | 0.11 |) | 3.12 | * | 3.52 |
| PZ-201A-SS DUP DIS | 8/1/2012 | 2.05 | 0.53 | 0.14 | J | 0.09 | 0.11 | 0.13 | UJ+ | 1.65 | 0.46 | 0.12 | J | 3.70 | * | 4.99 |
| PZ-202-SS DIS | 8/2/2012 | 1.15 | 0.38 | 0.21 | | 0.16 | 0.15 | 0.14 | J | 0.57 | 0.26 | 0.15 | J | 1.88 | | 1.77 |
| PZ-203-SS DIS | 8/1/2012 | 3.37 | 0.69 | 0.14 | J | 0.15 | 0.14 | 0.15 | J+ | 0.66 | 0.26 | 0.13 | J | 4.19 | | 2.05 |
| PZ-204A-SS DIS | 8/2/2012 | 1.98 | 0.60 | 0.15 | | 0.21 | 0.20 | 0.21 | U | 1.66 | 0.54 | 0.20 | | 3.64 | * | 5.05 |
| PZ-204-SS DIS | 8/3/2012 | 3.88 | 0.78 | 0.10 | J | 0.39 | 0.23 | 0.18 | J | 2.95 | 0.65 | 0.15 | J | 7.22 | | 8.96 |
| PZ-205-AS DIS | 8/3/2012 | 0.68 | 0.37 | 0.27 | J | 0.17 | 0.22 | 0.33 | UJ | 0.11 | 0.16 | 0.24 | UJ | 0.68 | * | 0.86 |
| PZ-205-SS DIS | 8/3/2012 | 0.35 | 0.20 | 0.15 | J | -0.02 | 0.07 | 0.18 | UJ | 0.31 | 0.19 | 0.17 | J | 0.66 | * | 1.01 |
| PZ-206-SS DIS | 8/7/2012 | 0.27 | 0.19 | 0.17 | J | 0.04 | 0.10 | 0.22 | UJ | 0.04 | 0.08 | 0.15 | UJ | 0.27 | * | 0.56 |
| PZ-207-AS DIS | 8/8/2012 | 0.06 | 0.14 | 0.27 | UJ | 0.04 | 0.10 | 0.21 | UJ | 0.08 | 0.13 | 0.23 | UJ | ND | | 0.78 |
| PZ-208-SS DIS | 8/2/2012 | 1.88 | 0.55 | 0.20 | | 0.15 | 0.16 | 0.19 | UJ+ | 0.82 | 0.37 | 0.34 | | 2.70 | * | 2.52 |
| PZ-302-AI DIS | 8/9/2012 | 5.50 | 1.25 | 0.18 | J | 0.09 | 0.14 | 0.23 | UJ | 4.01 | 1.00 | 0.18 | J | 9.51 | * | 12.04 |

Table 6: Summary of Uranium Results from OU-1 Additional Groundwater Sampling

| | | | Uraniu | m-234 | | | Uraniu | m-235 | | | Uraniu | m-238 | | тота | | |
|---------------|-----------|--------|--------|-------|--------|--------|--------|-------|----------|--------|--------|-------|--------|-------|----------|---------|
| | C | | | | CINIA! | | | | CINIAI | | | | CIALAL | U-234 | | Total |
| | Sample | ļ | 0511 | | FINAL | | 0511 | | FINAL | | 0011 | | FINAL | U-235 | | Uranium |
| Sample ID | Date | Result | CSU | MDA | Q | Result | CSU | MDA | Q | Result | CSU | MDA | Q | U-238 | <u> </u> | (ug/l) |
| PZ-303-AS DIS | 8/10/2012 | -0.01 | 0.18 | 0.53 | UJ | 0.10 | 0.27 | 0.59 | UJ | -0.16 | 0.21 | 0.72 | IJ | ND | | 2.42 |
| PZ-304-AI DIS | 8/10/2012 | 1.27 | 0.56 | 0.36 | J | 0.00 | 0.18 | 0.39 | UJ | 0.58 | 0.41 | 0.48 | J . | 1.85 | * | 1.91 |
| PZ-304-AS DIS | 8/10/2012 | 0.07 | 0.35 | 0.83 | UJ | -0.14 | 0.31 | 0.90 | UJ | 0.03 | 0.25 | 0.67 | UJ | ND | | 2.43 |
| PZ-305-AI DIS | 8/8/2012 | 0.07 | 0.11 | 0.19 | U | 0.20 | 0.22 | 0.30 | U | -0.01 | 0.09 | 0.26 | U | ND | | 0.92 |
| S-5 TOT | 8/14/2012 | 0.99 | 0.72 | 0.66 | j | 0.00 | 0.38 | 0.81 | UJ | 0.19 | 0.31 | 0.49 | UJ | 0.99 | * | 1.84 |
| S-8 TOT | 8/9/2012 | 1.79 | 0.72 | 0.50 | j | 0.06 | 0.35 | 0.62 | LU | 2.36 | 1.06 | 0.50 | 1 | 4.15 | * | 7.31 |
| S-10 TOT | 8/8/2012 | 1.00 | 0.44 | 0.22 | 1 | 0.20 | 0.21 | 0.22 | UJ UJ | 0.83 | 0.39 | 0.20 | j | 1.84 | * | 2.59 |
| S-61 TOT | 8/7/2012 | 1.47 | 0.46 | 0.18 | • | 0.04 | 0.10 | 0.22 | U | 1.28 | 0.42 | 0.13 | Ĵ | 2.76 | * | 3.93 |
| S-82 TOT | 8/10/2012 | 1.21 | 0.52 | 0.29 | j | 0.06 | 0.17 | 0.37 | UJ | 0.98 | 0.46 | 0.22 | J | 2.18 | * | 3.08 |
| S-84 TOT | 8/6/2012 | 0.57 | 0.30 | 0.21 | j | 0.06 | 0.12 | 0.23 | UJ | 0.33 | 0.22 | 0.20 | j | 0.89 | * | 1.07 |
| I-4 TOT | 8/14/2012 | 0.22 | 0.38 | 0.67 | UJ | 0.00 | 0.38 | 0.83 | UJ | 0.11 | 0.31 | 0.67 | UJ | ND | | 2.37 |
| I-9 TOT | 8/14/2012 | 0.20 | 0.17 | 0.16 | J | 0.04 | 0.12 | 0.26 | U | 0.11 | 0.14 | 0.21 | UJ | 0.20 | * | 0.75 |
| 1-9 DUP TOT | 8/14/2012 | 0.37 | 0.24 | 0.18 | J | -0.02 | 0.09 | 0.23 | U | 0.11 | 0.14 | 0.22 | U | 0.37 | * | 0.76 |
| I-11 TOT | 8/8/2012 | 1.19 | 0.53 | 0.23 | J | 0.06 | 0.18 | 0.39 | UJ | 0.94 | 0.47 | 0.31 | J | 2.13 | * | 2.97 |
| I-62 TOT | 8/9/2012 | 0.37 | 0.24 | 0.21 | J | 0.08 | 0.12 | 0.20 | U | 0.31 | 0.23 | 0.24 | J | 0.68 | * | 1.02 |
| I-65 TOT | 8/6/2012 | 1.34 | 0.41 | 0.11 | J | 0.05 | 0.09 | 0.17 | UJ | 1.10 | 0.36 | 0.13 | J | 2.44 | * | 3.35 |
| I-66 TOT | 8/10/2012 | 0.88 | 0.35 | 0.14 | | 0.03 | 0.08 | 0.17 | U | 0.55 | 0.27 | 0.18 | | 1.43 | * | 1.72 |
| I-67 TOT | 8/10/2012 | 0.85 | 0.34 | 0.20 | | 0.07 | 0.13 | 0.22 | U | 0.74 | 0.32 | 0.21 | | 1.59 | * | 2.32 |
| I-68 TOT | 8/6/2012 | 2.47 | 1.49 | 1.05 | J | -0.11 | 0.44 | 1.13 | UJ | 3.04 | 1.67 | 0.91 | J | 5.52 | * | 9.60 |
| I-73 TOT | 8/4/2012 | 1.39 | 0.50 | 0.16 | J | 0.12 | 0.16 | 0.22 | IJ | 0.99 | 0.41 | 0.21 | J | 2.39 | * | 3.06 |
| D-3 TOT | 8/8/2012 | 0.19 | 0.26 | 0.40 | UJ | -0.04 | 0.16 | 0.41 | IJ | 0.16 | 0.26 | 0.45 | ΟJ | ND | | 1.52 |
| D-3 DUP TOT | 8/8/2012 | 0.16 | 0.22 | 0.34 | UJ | 0.18 | 0.23 | 0.32 | UJ | -0.20 | 0.15 | 0.56 | UJ | ND | | 1.83 |
| D-6 TOT | 8/7/2012 | 0.19 | 0.17 | 0.16 | j | 0.13 | 0.17 | 0.25 | U | 0.07 | 0.12 | 0.21 | U | 0.19 | * | 0.73 |
| D-6 DUP TOT | 8/7/2012 | 0.36 | 0.21 | 0.13 | J | -0.01 | 0.07 | 0.16 | U | 0.17 | 0.15 | 0.17 | J | 0.53 | * | 0.58 |
| D-12 TOT | 8/8/2012 | 0.05 | 0.11 | 0.22 | U | 0.19 | 0.19 | 0.20 | U | 0.12 | 0.16 | 0.24 | U | ND | | 0.80 |

Table 6: Summary of Uranium Results from OU-1 Additional Groundwater Sampling

| | | | Uraniu | m-234 | | | Uraniu | m-235 | | 1 | Uraniu | m-238 | | TOTAL | | |
|----------------|-----------|--------|--------|-------|-------|--------|--------|-------|-------|--------|--------|-------|-------|---------|---|---------|
| | | | | | | | | | | Í | | | | U-234 + | + | Total |
| | Sample | | | | FINAL | | | | FINAL | | | | FINAL | U-235 + | | Uranium |
| Sample ID | Date | Result | CSU | MDA | Q | Result | CSU | MDA | Q | Result | CSU | MDA | Q | U-238 | | (ug/l) |
| D-13 TOT | 8/10/2012 | 0.17 | 0.15 | 0.17 | J | -0.01 | 0.07 | 0.16 | U | 0.04 | 0.08 | 0.16 | U | 0.17 | * | 0.56 |
| D-13 DUP TOT | 8/10/2012 | 0.12 | 0.13 | 0.18 | U | 0.02 | 0.07 | 0.19 | U | 0.10 | 0.13 | 0.20 | U | ND | | 0.69 |
| D-14 TOT | 8/10/2012 | 1.36 | 0.68 | 0.43 | J | 0.00 | 0.25 | 0.55 | UJ | 1.51 | 0.72 | 0.39 | J | 2.87 | * | 4.77 |
| D-81 TOT | 8/9/2012 | 1.92 | 0.61 | 0.21 | | 0.12 | 0.17 | 0.25 | U | 1.36 | 0.50 | 0.21 | | 3.28 | * | 4.16 |
| D-83 TOT | 8/9/2012 | -0.07 | 0.11 | 0.33 | UJ | 0.00 | 0.12 | 0.36 | UJ | 0.06 | 0.13 | 0.27 | UJ | ND | | 0.96 |
| D-85 TOT | 8/6/2012 | 3.68 | 0.80 | 0.19 | J | 0.32 | 0.22 | 0.21 | J | 4.50 | 0.92 | 0.15 | J | 8.51 | | 13.57 |
| D-87 TOT | 8/1/2012 | 0.14 | 0.16 | 0.22 | U | 0.04 | 0.12 | 0.27 | UJ+ | 0.28 | 0.20 | 0.15 | J | 0.28 | * | 0.96 |
| D-93 TOT | 8/14/2012 | 0.78 | 0.44 | 0.26 | ţ | 0.04 | 0.15 | 0.37 | U | 0.20 | 0.23 | 0.30 | UJ | 0.78 | * | 1.05 |
| LR-100 TOT | 8/13/2012 | 1.24 | 0.88 | 0.77 | J | 0.09 | 0.34 | 0.86 | UJ | 0.20 | 0.38 | 0.69 | UJ | 1.24 | * | 2.46 |
| LR-103 TOT | 8/13/2012 | 0.77 | 0.48 | 0.39 | J | 0.23 | 0.29 | 0.38 | UJ | 0.64 | 0.44 | 0.35 | j | 1.41 | * | 2.09 |
| LR-104 DUP TOT | 8/13/2012 | 2.88 | 0.76 | 0.22 | | 0.04 | 0.12 | 0.27 | U | 2.54 | 0.70 | 0.16 | J | 5.42 | * | 7.68 |
| LR-104 TOT | 8/13/2012 | 2.99 | 0.91 | 0.32 | J | 0.45 | 0.36 | 0.36 | J | 2.44 | 0.80 | 0.26 | J | 5.88 | | 7.49 |
| LR-105 TOT | 8/1/2012 | 0.01 | 0.17 | 0.48 | UJ | 0.05 | 0.20 | 0.52 | UJ+ | 0.00 | 0.00 | 0.22 | UJ | ND | | 0.88 |
| MW-102 TOT | 8/7/2012 | 3.31 | 0.84 | 0.17 | J | 0.24 | 0.23 | 0.27 | U | 2.40 | 0.68 | 0.17 | | 5.71 | * | 7.29 |
| MW-103 TOT | 8/11/2012 | 6.96 | 1.37 | 0.16 | | 0.34 | 0.26 | 0.26 | J | 6.21 | 1.26 | 0.15 | | 13.51 | | 18.66 |
| MW-104 TOT | 8/9/2012 | 1.34 | 0.63 | 0.36 | J | 0.02 | 0.16 | 0.45 | UJ | 1.09 | 0.56 | 0.36 | J | 2.43 | * | 3.44 |
| MW-1204 TOT | 8/2/2012 | 0.14 | 0.21 | 0.31 | UJ | -0.05 | 0.19 | 0.49 | UJ | 0.12 | 0.21 | 0.36 | UJ | ND | | 1.30 |
| PZ-100-KS TOT | 8/16/2012 | 0.23 | 0.16 | 0.14 | J | 0.07 | 0.11 | 0.20 | UJ | -0.01 | 0.06 | 0.14 | UJ | 0.23 | * | 0.51 |
| PZ-100-SD TOT | 7/31/2012 | 0.59 | 0.40 | 0.37 | J | -0.02 | 0.15 | 0.35 | UJ | 0.07 | 0.30 | 0.61 | UJ | 0.59 | * | 1.98 |
| PZ-100-SS TOT | 7/31/2012 | 5.06 | 0.91 | 0.13 | j | 0.06 | 0.09 | 0.17 | UJ | 2.35 | 0.54 | 0.12 | J | 7.41 | * | 7.08 |
| PZ-101-SS TOT | 8/7/2012 | 0.53 | 0.46 | 0.44 | J | 0.00 | 0.32 | 0.69 | UJ | -0.02 | 0.20 | 0.61 | UJ | 0.53 | * | 2.13 |
| PZ-102R-SS TOT | 8/13/2012 | 2.10 | 0.51 | 0.11 | J | 0.23 | 0.17 | 0.17 | J | 1.21 | 0.37 | 0.14 | J | 3.55 | | 3.72 |
| PZ-102-SS TOT | 8/13/2012 | 1.24 | 0.43 | 0.19 | | 0.16 | 0.17 | 0.23 | U | 1.00 | 0.38 | 0.14 | J | 2.24 | * | 3.09 |
| PZ-103-SS TOT | 8/7/2012 | 0.15 | 0.12 | 0.10 | J | 0.06 | 0.09 | 0.13 | UJ | 0.40 | 0.21 | 0.15 | J | 0.55 | * | 1.25 |
| PZ-104-KS TOT | 8/13/2012 | 0.56 | 0.23 | 0.12 | J | 0.08 | 0.11 | 0.17 | UJ | 0.37 | 0.19 | 0.13 | J | 0.93 | * | 1.18 |
| PZ-104-SD TOT | 8/1/2012 | 0.53 | 0.36 | 0.32 | J | 0.07 | 0.18 | 0.39 | UJ | 0.58 | 0.36 | 0.22 | J | 1.11 | * | 1.90 |

Table 6: Summary of Uranium Results from OU-1 Additional Groundwater Sampling

| | | 1 | Uraniu | m-234 | | | Uraniu | m-235 | | | Uraniu | m-238 | | TOTA | | |
|--------------------|-----------|--------|--------|-------|-------|--------|--------|-------|-------|--------|--------|-------|--------|-------|--------------|---------|
| | Campla | | | | FINAL | | | | FINAL | | | | CINIAL | U-234 | | Total |
| 6 1 15 | Sample | ١ | 6611 | | | | 0011 | | | | CCLI | | FINAL | U-235 | | Uranium |
| Sample ID | Date | Result | CSU | MDA | Q | Result | CSU | MDA | Q | Result | CSU | MDA | Q | U-238 | _ <u>-</u> _ | (ug/l) |
| PZ-104-SS TOT | 8/1/2012 | 0.86 | 0.32 | 0.18 | J | 0.08 | 0.11 | 0.18 | UJ | 0.63 | 0.27 | 0.15 | J | 1.49 | * | 1.98 |
| PZ-105-SS TOT | 8/1/2012 | 3.42 | 0.77 | 0.20 | | 0.05 | 0.10 | 0.20 | UJ+ | 1.84 | 0.52 | 0.16 | | 5.26 | * | 5.56 |
| PZ-106-KS TOT | 8/14/2012 | 2.41 | 0.65 | 0.15 | | 0.32 | 0.23 | 0.19 | J | 0.90 | 0.37 | 0.20 | | 3.63 | | 2.84 |
| PZ-106-SD TOT | 7/31/2012 | 0.54 | 0.49 | 0.52 | J | -0.02 | 0.24 | 0.51 | UJ | 0.00 | 0.21 | 0.62 | UJ | 0.54 | * | 2.07 |
| PZ-106-SS TOT | 7/31/2012 | 1.12 | 0.38 | 0.12 | | 0.03 | 0.10 | 0.21 | U | 0.31 | 0.19 | 0.17 | J | 1.42 | * | 1.01 |
| PZ-107-SS TOT | 8/4/2012 | 2.50 | 0.73 | 0.31 | J | 0.53 | 0.33 | 0.20 | J | 2.35 | 0.69 | 0.22 | J | 5.38 | | 7.23 |
| PZ-109-SS TOT | 8/2/2012 | 1.31 | 0.53 | 0.20 | J | 0.06 | 0.16 | 0.35 | UJ | 0.75 | 0.40 | 0.28 | J | 2.06 | * | 2.39 |
| PZ-110-SS TOT | 8/2/2012 | 0.10 | 0.13 | 0.20 | UJ | -0.01 | 0.10 | 0.20 | UJ | 0.08 | 0.14 | 0.24 | UJ | ND | | 0.82 |
| PZ-111-K3 TOT | 8/13/2012 | 6.95 | 1.28 | 0.13 | J | 0.75 | 0.34 | 0.16 | J | 2.94 | 0.70 | 0.17 | j | 10.64 | | 9.10 |
| PZ-111-SD TOT | 8/1/2012 | 0.38 | 0.24 | 0.21 | J | 0.05 | 0.12 | 0.24 | UJ+ | 0.28 | 0.20 | 0.17 | J | 0.66 | * | 0.93 |
| PZ-112-AS TOT | 8/8/2012 | 0.12 | 0.15 | 0.19 | UJ | 0.05 | 0.15 | 0.31 | UJ | 0.03 | 0.09 | 0.19 | UJ | ND | | 0.71 |
| PZ-113 AD DUP TOT | 8/3/2012 | 0.58 | 0.28 | 0.20 | | 0.08 | 0.13 | 0.21 | U | 0.13 | 0.13 | 0.17 | U | 0.58 | * | 0.59 |
| PZ-113-AD TOT | 8/3/2012 | 0.14 | 0.19 | 0.28 | UJ | 0.00 | 0.16 | 0.35 | UJ | -0.01 | 0.09 | 0.20 | UJ | ND | | 0.74 |
| PZ-113-AS TOT | 8/8/2012 | 0.77 | 0.41 | 0.29 | J | 0.00 | 0.17 | 0.37 | UJ | 0.64 | 0.37 | 0.22 | J | 1.41 | * | 2.07 |
| PZ-113-SS TOT | 8/4/2012 | 3.65 | 1.13 | 0.46 | J | 1.85 | 0.80 | 0.36 | J | 1.26 | 0.60 | 0.40 | J | 6.75 | | 4.60 |
| PZ-114-AS TOT | 7/31/2012 | 0.10 | 0.15 | 0.25 | ίU | 0.18 | 0.22 | 0.30 | UJ | 0.12 | 0.18 | 0.29 | UJ | ND | | 0.99 |
| PZ-115-SS TOT | 7/31/2012 | 1.93 | 0.74 | 0.30 | J | 0.20 | 0.24 | 0.30 | UJ | 0.67 | 0.41 | 0.27 | J | 2.60 | * | 2.13 |
| PZ-116-SS TOT | 8/3/2012 | 5.93 | 1.03 | 0.14 | J | 0.31 | 0.19 | 0.17 | J | 1.76 | 0.45 | 0.09 | J | 7.99 | | 5.39 |
| PZ-200 SS DUP TOT | 8/2/2012 | 0.32 | 0.20 | 0.18 | J | 0.07 | 0.12 | 0.20 | UJ | 0.34 | 0.20 | 0.14 | J | 0.66 | * | 1.09 |
| PZ-200-SS TOT | 8/2/2012 | 0.54 | 0.27 | 0.18 | J | 0.04 | 0.10 | 0.22 | UJ | 0.59 | 0.27 | 0.13 | J | 1.14 | * | 1.87 |
| PZ-201A-SS DUP TOT | 8/1/2012 | 1.64 | 0.70 | 0.31 | J | 0.08 | 0.22 | 0.47 | UJ+ | 1.58 | 0.70 | 0.42 | J | 3.23 | * | 4.93 |
| PZ-201A-SS TOT | 8/1/2012 | 2.09 | 0.51 | 0.10 | J | 0.08 | 0.10 | 0.14 | UJ+ | 1.56 | 0.42 | 0.13 | J | 3.66 | * | 4.72 |
| PZ-202-SS TOT | 8/2/2012 | 1.18 | 0.73 | 0.64 | J | 0.08 | 0.23 | 0.55 | UJ | 0.88 | 0.61 | 0.49 | J | 2.06 | * | 2.88 |
| PZ-203-SS TOT | 8/1/2012 | 4.11 | 0.77 | 0.16 | J | 0.02 | 0.05 | 0.11 | UJ+ | 0.55 | 0.22 | 0.12 | J | 4.67 | * | 1.70 |
| PZ-204A-SS TOT | 8/2/2012 | 1.71 | 0.56 | 0.22 | J | 0.16 | 0.18 | 0.24 | UJ | 1.27 | 0.47 | 0.21 | J | 2.98 | * | 3.89 |
| PZ-204-SS TOT | 8/3/2012 | 3.81 | 0.84 | 0.18 | | 0.26 | 0.21 | 0.22 | J | 2.28 | 0.60 | 0.14 | | 6.34 | | 6.90 |

Table 6: Summary of Uranium Results from OU-1 Additional Groundwater Sampling

| | | 1 | Uraniu | m-234 | | | Uraniu | m-235 | | | Uraniu | m-238 | | TOTA | L | |
|---------------|-----------|--------|--------|-------|-------|--------|--------|-------|-------|--------|--------|-------|-------|-------|---|---------|
| | | | | | | | | | | | | | | U-234 | + | Total |
| | Sample | | | | FINAL | | | | FINAL | | | | FINAL | U-235 | + | Uranium |
| Sample ID | Date | Result | CSU | MDA | Q | Result | CSU | MDA | Q | Result | CSU | MDA | Q | U-238 | | (ug/l) |
| PZ-205-AS TOT | 8/3/2012 | 0.17 | 0.15 | 0.16 | J | 0.03 | 0.07 | 0.16 | U | 0.12 | 0.12 | 0.13 | U | 0.17 | * | 0.45 |
| PZ-205-SS TOT | 8/3/2012 | 0.44 | 0.27 | 0.22 | J | -0.02 | 0.09 | 0.24 | U | 0.34 | 0.23 | 0.19 | J | 0.79 | * | 1.14 |
| PZ-206-SS TOT | 8/7/2012 | 0.25 | 0.18 | 0.19 | J | 0.04 | 0.10 | 0.21 | UJ | 0.21 | 0.17 | 0.20 | J | 0.47 | * | 0.74 |
| PZ-207-AS TOT | 8/8/2012 | 0.16 | 0.30 | 0.55 | UJ | 0.07 | 0.27 | 0.67 | UJ | 0.16 | 0.30 | 0.54 | UJ | ND | | 1.94 |
| PZ-208-SS TOT | 8/2/2012 | 2.04 | 0.62 | 0.18 | | 0.37 | 0.28 | 0.28 | J+ | 1.64 | 0.54 | 0.22 | | 4.04 | | 5.04 |
| PZ-302-AI TOT | 8/9/2012 | 5.02 | 1.01 | 0.13 | | 0.32 | 0.23 | 0.24 | J | 3.57 | 0.80 | 0.13 | | 8.91 | | 10.80 |
| PZ-303-AS TOT | 8/10/2012 | 0.48 | 0.38 | 0.32 | J | -0.06 | 0.18 | 0.50 | UJ | 0.12 | 0.20 | 0.31 | UJ | 0.48 | * | 1.17 |
| PZ-304-AI TOT | 8/10/2012 | 2.71 | 1.40 | 0.65 | J | 0.41 | 0.63 | 1.03 | UJ | 1.55 | 1.01 | 0.64 | J | 4.25 | * | 5.08 |
| PZ-304-AS TOT | 8/10/2012 | 0.03 | 0.19 | 0.51 | UJ | 0.19 | 0.31 | 0.49 | UJ | -0.02 | 0.18 | 0.39 | UJ | ND | | 1.39 |
| PZ-305-AI TOT | 8/8/2012 | 0.88 | 0.41 | 0.24 | J | 0.07 | 0.15 | 0.30 | UJ | 0.81 | 0.40 | 0.28 | J | 1.69 | * | 2.55 |

Notes:

All values are in units of picoCuries per liter (pCi/l), except as noted.

DIS = dissolved sample (field filtered sample); TOT = total sample (unfiltered sample)

DUP = Duplicate samples; Field duplicates were collected from the following locations: DUP 01 = PZ-201A-SS, DUP 02 = PZ-200-SS,

DUP 03 = PZ-113-AD, DUP-04 = D-6, DUP-05 = D-3, DUP 06 = D-13, DUP 07 = LR-104, and DUP 08 = I-9.

CSU = Combined Standard Uncertainty (2-sigma)

Data Validation Qualifiers (Final Q) include: U = Non-detect at the reported value;

UJ = Non-Detect at the estimated reported value; UJ+ = Non-Detect at the estimated reported value which may be biased high;

J = estimated result; J+ = estimated result which may be biased high.

Total U-238 + U-235 +U-234 based on sum of detected values only. The * flag indicates one or more of the individual isotopes was non-detect.

Total uranium values in ug/l based on use of Minimum Detectable Activity (MDA) values for non-detect results.

MCL = Maximum Contaminant Level for drinking water systems of 30 ug/l for total Uranium

Table 7: Summary of Thorium Isotope Results from OU-1 Additional Groundwater Sampling

| | | | Thorium | | FINAL | | Thorium | | FINAL | | Thorium | | FINAL | TOTAL THORIUI | VI- |
|--------------|-------------|--------|---------|------|-------|--------|---------|------|-------|--------|---------|------|-------|------------------|-------|
| Sample ID | Sample Date | Result | CSU | MDA | Q | Result | CSU | MDA | Q | Result | CSU | MDA | Q | 228 + 230 - | + 232 |
| S-5 TOT | 8/14/2012 | 0.13 | 0.17 | 0.27 | U | 0.45 | 0.32 | 0.35 | j+ | 0.13 | 0.17 | 0.26 | U | 0.45 | * |
| S-8 TOT | 8/9/2012 | 0.48 | 0.25 | 0.13 | | 0.20 | 0.16 | 0.17 | J | 0.07 | 0.10 | 0.15 | U | 0.67 | * |
| S-10 TOT | 8/8/2012 | 0.06 | 0.16 | 0.33 | U | 0.53 | 0.36 | 0.22 | J | -0.08 | 0.12 | 0.38 | U | 0.53 | * |
| S-61 TOT | 8/7/2012 | 0.02 | 0.22 | 0.50 | UJ | 2.11 | 0.84 | 0.29 | J | 0.10 | 0.18 | 0.33 | ΟJ | 2.11 | * |
| S-82 TOT | 8/10/2012 | 0.86 | 0.34 | 0.20 | J | 0.29 | 0.18 | 0.13 | J- | 0.24 | 0.16 | 0.13 | J | 1.40 | |
| S-84 TOT | 8/6/2012 | 0.18 | 0.27 | 0.46 | UJ | 1.33 | 0.58 | 0.27 | J | 0.36 | 0.28 | 0.30 | J | 1.68 | * |
| I-4 TOT | 8/14/2012 | 0.49 | 0.26 | 0.18 | J | 0.83 | 0.35 | 0.15 | J+ | 0.04 | 0.08 | 0.15 | UJ | 1.33 | * |
| I-9 TOT | 8/14/2012 | 0.07 | 0.18 | 0.36 | U | 0.12 | 0.16 | 0.24 | UJ+ | -0.01 | 0.08 | 0.25 | U | ND | * |
| I-9 DUP TOT | 8/14/2012 | -0.01 | 0.04 | 0.10 | IJ | 0.11 | 0.11 | 0.13 | UJ+ | 0.04 | 0.07 | 0.13 | UJ | ND | * |
| I-11 TOT | 8/8/2012 | 0.19 | 0.22 | 0.29 | UJ | 0.21 | 0.22 | 0.28 | UJ | 0.04 | 0.10 | 0.21 | UJ | ND | * |
| I-62 TOT | 8/9/2012 | 0.19 | 0.22 | 0.30 | UJ | 0.22 | 0.21 | 0.21 | J | 0.18 | 0.19 | 0.21 | UJ | 0.22 | * |
| I-65 TOT | 8/6/2012 | 0.60 | 0.37 | 0.34 | J | 0.20 | 0.19 | 0.20 | UJ | 0.20 | 0.19 | 0.18 | J | 0.00 | * |
| I-66 TOT | 8/10/2012 | 0.09 | 0.12 | 0.18 | UJ | 0.34 | 0.20 | 0.13 | J- | 0.01 | 0.05 | 0.13 | UJ | 0.34 | * |
| I-67 TOT | 8/10/2012 | 0.11 | 0.12 | 0.18 | UJ | 1.53 | 0.48 | 0.14 | J- | -0.01 | 0.05 | 0.11 | UJ | 1.53 | * |
| I-68 TOT | 8/6/2012 | 2.08 | 0.65 | 0.14 | | 1.82 | 0.61 | 0.19 | | 0.70 | 0.32 | 0.13 | | 4.60 | |
| I-73 TOT | 8/4/2012 | 0.08 | 0.11 | 0.15 | U | 0.43 | 0.25 | 0.13 | J | 0.15 | 0.14 | 0.15 | U | 0.43 | * |
| D-3 TOT | 8/8/2012 | 0.08 | 0.13 | 0.21 | U | 0.25 | 0.21 | 0.22 | J | 0.00 | 0.10 | 0.21 | U | 0.25 | * |
| D-3 DUP TOT | 8/8/2012 | 0.11 | 0.11 | 0.12 | UJ | 0.22 | 0.17 | 0.16 | J | 0.05 | 0.09 | 0.16 | UJ | 0.22 | * |
| D-6 TOT | 8/7/2012 | 0.22 | 0.22 | 0.27 | UJ | 0.11 | 0.15 | 0.23 | UJ | 0.13 | 0.18 | 0.26 | UJ | ND | * |
| D-6 DUP TOT | 8/7/2012 | 0.29 | 0.26 | 0.31 | UJ | 0.37 | 0.27 | 0.22 | Į | 0.11 | 0.15 | 0.22 | UJ | 0.37 | * |
| D-12 TOT | 8/8/2012 | 0.09 | 0.12 | 0.16 | U | 0.27 | 0.21 | 0.21 | j | 0.02 | 0.10 | 0.23 | U | 0.27 | * |
| D-13 TOT | 8/10/2012 | 0.34 | 0.23 | 0.16 | | 0.44 | 0.26 | 0.15 | J | 0.09 | 0.12 | 0.15 | U | 0.78 | * |
| D-13 DUP TOT | 8/10/2012 | 0.52 | 0.35 | 0.29 | J | 0.30 | 0.27 | 0.31 | UJ- | 0.05 | 0.14 | 0.30 | UJ | 0.00 | * |
| D-14 TOT | 8/10/2012 | 1.95 | 0.70 | 0.28 | | 2.19 | 0.77 | 0.21 | | 1.91 | 0.68 | 0.21 | | 6.06 | |
| D-81 TOT | 8/9/2012 | 0.05 | 0.10 | 0.19 | UJ | 0.33 | 0.19 | 0.15 | J | 0.08 | 0.09 | 0.12 | UJ | 0.33 | * |
| D-83 TOT | 8/9/2012 | 0.22 | 0.20 | 0.25 | U | 0.26 | 0.19 | 0.15 | J | 0.02 | 0.07 | 0.17 | U | 0.26 | * |
| D-85 TOT | 8/6/2012 | 4.49 | 1.15 | 0.13 | | 7.84 | 1.92 | 0.13 | | 4.54 | 1.14 | 0.13 | | 16.87 | |
| D-87 TOT | 8/1/2012 | 0.09 | 0.13 | 0.22 | U | 0.17 | 0.14 | 0.11 | J+ | 0.10 | 0.10 | 0.11 | U | 0.17 | * |

Page 1 of 7 12/14/2012

Table 7: Summary of Thorium Isotope Results from OU-1 Additional Groundwater Sampling

| | | | Thorium | | FINAL | | Thorium | | FINAL | | Thorium CSU | | FINAL | TOTAL THORIUI | M- |
|----------------|-------------|-------|---------|------|-------|--------|---------|------|-------|--------|----------------|------|-------|------------------|----|
| Sample ID | Sample Date | | CSU | MDA | Q | Result | CSU | MDA | Q | Result | | MDA | Q | 228 + 230 + | |
| D-93 TOT | 8/14/2012 | 0.15 | 0.14 | 0.18 | UJ | 0.17 | 0.14 | 0.15 | J+ | 0.06 | 0.08 | 0.12 | UJ | 0.17 | * |
| LR-100 TOT | 8/13/2012 | 0.11 | 0.11 | 0.13 | UJ | 0.29 | 0.19 | 0.14 | J+ | 0.11 | 0.12 | 0.17 | UJ | 0.29 | * |
| LR-103 TOT | 8/13/2012 | 0.15 | 0.13 | 0.12 | J | 0.51 | 0.25 | 0.15 | J+ | 0.15 | 0.13 | 0.15 | J | 0.81 | |
| LR-104 DUP TOT | 8/13/2012 | 0.06 | 0.08 | 0.13 | UJ | 0.28 | 0.17 | 0.11 | J+ | 0.07 | 0.09 | 0.14 | UΊ | 0.28 | * |
| LR-104 TOT | 8/13/2012 | 0.10 | 0.12 | 0.17 | UJ | 0.31 | 0.21 | 0.19 | J+ | -0.09 | 0.08 | 0.26 | UJ | 0.31 | * |
| LR-105 TOT | 8/1/2012 | 0.07 | 0.10 | 0.15 | U | 0.83 | 0.39 | 0.15 | J+ | 0.14 | 0.15 | 0.15 | U | 0.83 | * |
| MW-102 TOT | 8/7/2012 | 0.20 | 0.24 | 0.35 | UJ | 0.40 | 0.29 | 0.21 | J | 0.12 | 0.16 | 0.24 | IJ | 0.40 | * |
| MW-103 TOT | 8/11/2012 | 3.50 | 0.94 | 0.14 | | 3.78 | 1.04 | 0.18 | J- | 3.40 | 0.91 | 0.14 | | 10.68 | |
| MW-104 TOT | 8/9/2012 | 0.99 | 0.38 | 0.20 | j | 0.89 | 0.35 | 0.16 | J | 0.85 | 0.33 | 0.12 | J | 2.73 | |
| MW-1204 TOT | 8/2/2012 | 0.17 | 0.18 | 0.26 | U | 0.00 | 0.00 | 0.40 | UJ- | -0.02 | 0.06 | 0.16 | U | ND | * |
| PURGE TANK TOT | 8/16/2012 | 0.15 | 0.25 | 0.43 | UJ | 0.88 | 0.46 | 0.21 | J | 0.42 | 0.31 | 0.28 | J | 1.31 | * |
| PZ-100-KS TOT | 8/16/2012 | 0.02 | 0.08 | 0.20 | U | 0.11 | 0.15 | 0.22 | UJ+ | -0.02 | 0.08 | 0.19 | U | ND | * |
| PZ-100-SD TOT | 7/31/2012 | -0.02 | 0.10 | 0.29 | IJ | 1.05 | 0.43 | 0.18 | J | 0.05 | 0.09 | 0.17 | UJ | 1.05 | * |
| PZ-100-SS TOT | 7/31/2012 | -0.02 | 0.07 | 0.21 | U | 0.10 | 0.12 | 0.14 | UJ | 0.02 | 0.06 | 0.12 | U | ND | * |
| PZ-101-SS TOT | 8/7/2012 | 0.08 | 0.12 | 0.18 | U | 0.13 | 0.13 | 0.14 | U | 0.00 | 0.09 | 0.20 | U | ND | * |
| PZ-102R-SS TOT | 8/13/2012 | -0.01 | 0.06 | 0.13 | UJ | 0.13 | 0.12 | 0.12 | J- | 0.10 | 0.11 | 0.12 | UJ | 0.13 | * |
| PZ-102-SS TOT | 8/13/2012 | 0.64 | 0.30 | 0.19 | J | 0.72 | 0.33 | 0.15 | J+ | 0.66 | 0.30 | 0.15 | J | 2.02 | |
| PZ-103-SS TOT | 8/7/2012 | 0.33 | 0.23 | 0.18 | J | 0.88 | 0.39 | 0.16 | | 0.20 | 0.18 | 0.20 | | 1.41 | |
| PZ-104-KS TOT | 8/13/2012 | 0.02 | 0.06 | 0.13 | UJ | 0.18 | 0.15 | 0.14 | J+ | 0.14 | 0.14 | 0.17 | UJ | 0.18 | * |
| PZ-104-SD TOT | 8/1/2012 | 0.11 | 0.13 | 0.16 | U | 0.19 | 0.19 | 0.23 | IJ | 0.07 | 0.11 | 0.16 | U | ND | * |
| PZ-104-SS TOT | 8/1/2012 | -0.02 | 0.07 | 0.18 | U | 0.30 | 0.21 | 0.14 | J | 0.03 | 0.09 | 0.20 | U | 0.30 | * |
| PZ-105-SS TOT | 8/1/2012 | 0.00 | 0.11 | 0.27 | U | 0.20 | 0.19 | 0.25 | UJ+ | 0.05 | 0.11 | 0.22 | U | ND | * |
| PZ-106-KS TOT | 8/14/2012 | 0.07 | 0.11 | 0.18 | UJ | 0.21 | 0.18 | 0.20 | J+ | 0.00 | 0.11 | 0.28 | UJ | 0.21 | * |
| PZ-106-SD TOT | 7/31/2012 | 0.17 | 0.17 | 0.20 | U | 1.39 | 0.54 | 0.15 | J | 0.18 | 0.17 | 0.15 | J | 1.57 | * |
| PZ-106-SS TOT | 7/31/2012 | 0.08 | 0.10 | 0.12 | U | 0.11 | 0.11 | 0.12 | UJ | 0.05 | 0.08 | 0.12 | U | ND | * |
| PZ-107-SS TOT | 8/4/2012 | 0.41 | 0.23 | 0.16 | J | 0.69 | 0.30 | 0.11 | J | 1.06 | 0.38 | 0.11 | J | 2.16 | |
| PZ-109-SS TOT | 8/2/2012 | 0.03 | 0.11 | 0.23 | UJ | 0.13 | 0.13 | 0.16 | UJ- | 0.03 | 0.08 | 0.16 | UJ | ND | * |
| PZ-110-SS TOT | 8/2/2012 | -0.02 | 0.06 | 0.16 | UJ | 0.29 | 0.20 | 0.15 | J- | 0.09 | 0.12 | 0.18 | UJ | 0.29 | * |

Page 2 of 7 12/14/2012

Table 7: Summary of Thorium Isotope Results from OU-1 Additional Groundwater Sampling

| | | | Thorium | | FINAL | | Thorium | | FINAL | | Thorium | | FINAL | TOTAL THORIU | M- |
|--------------------|-------------|--------|---------|------|-------|--------|---------|------|-------|--------|---------|------|------------|-----------------|-------|
| Sample ID | Sample Date | Result | CSU | MDA | Q | Result | CSU | MDA | Q | Result | CSU | MDA | Q | 228 + 230 - | + 232 |
| PZ-111-K3 TOT | 8/13/2012 | 0.07 | 0.09 | 0.14 | UJ | 0.29 | 0.19 | 0.16 | J+ | -0.01 | 0.05 | 0.14 | UJ | 0.29 | * |
| PZ-111-SD TOT | 8/1/2012 | 0.10 | 0.12 | 0.15 | UJ | 0.14 | 0.13 | 0.12 | J+ | 0.05 | 0.08 | 0.12 | UJ | 0.14 | * |
| PZ-112-AS TOT | 8/8/2012 | 0.21 | 0.19 | 0.20 | J | 0.10 | 0.13 | 0.17 | UJ | 0.03 | 0.08 | 0.17 | IJ | 0.00 | * |
| | | | | | | | | | | | | | | | |
| PZ-113-AD DUP TOT | 8/3/2012 | 0.21 | 0.16 | 0.14 | J | 0.67 | 0.30 | 0.11 | J | 0.02 | 0.05 | 0.11 | UJ | 0.87 | * |
| PZ-113-AD TOT | 8/3/2012 | 0.07 | 0.12 | 0.22 | UJ | 0.11 | 0.12 | 0.14 | UJ | 0.02 | 0.06 | 0.12 | IJ | ND | * |
| PZ-113-AS TOT | 8/8/2012 | 0.06 | 0.11 | 0.21 | IJ | 0.07 | 0.09 | 0.14 | UJ | 0.04 | 0.08 | 0.14 | UJ | ND | * |
| PZ-113-SS TOT | 8/4/2012 | 0.01 | 0.09 | 0.24 | IJ | 0.15 | 0.16 | 0.17 | UJ | -0.06 | 0.09 | 0.29 | UJ | ND | * |
| PZ-114-AS TOT | 7/31/2012 | 0.00 | 0.00 | 0.08 | U | 0.68 | 0.32 | 0.14 | J | 0.06 | 0.08 | 0.13 | . U | 0.68 | * |
| PZ-115-SS TOT | 7/31/2012 | 0.18 | 0.21 | 0.31 | U | 0.75 | 0.40 | 0.25 | J | 0.01 | 0.09 | 0.23 | U | 0.75 | * |
| PZ-116-SS TOT | 8/3/2012 | 0.03 | 0.11 | 0.23 | IJ | 0.02 | 0.09 | 0.21 | ΟĴ | 0.01 | 0.07 | 0.18 | UJ | ND | * |
| PZ-200-SS DUP TOT | 8/2/2012 | 0.01 | 0.12 | 0.31 | UJ | 0.31 | 0.24 | 0.19 | J- | 0.07 | 0.11 | 0.17 | UJ | 0.31 | * |
| PZ-200-SS TOT | 8/2/2012 | 0.14 | 0.15 | 0.23 | UJ | 0.40 | 0.21 | 0.14 | J- | 0.11 | 0.11 | 0.15 | UJ | 0.40 | * |
| | | | | | | | | | | | | | | | |
| PZ-201A-SS DUP TOT | 8/1/2012 | 0.06 | 0.09 | 0.13 | U | 0.19 | 0.17 | 0.19 | J+ | -0.01 | 0.06 | 0.13 | U | 0.19 | * |
| PZ-201A-SS TOT | 8/1/2012 | 0.13 | 0.17 | 0.25 | U | 0.18 | 0.18 | 0.23 | UJ+ | -0.03 | 0.08 | 0.22 | U | ND | * |
| PZ-202-SS TOT | 8/2/2012 | 0.81 | 0.35 | 0.22 | | 0.44 | 0.24 | 0.14 | J- | 0.90 | 0.36 | 0.12 | | 2.15 | |
| PZ-203-SS TOT | 8/1/2012 | 0.17 | 0.19 | 0.28 | U | 0.20 | 0.19 | 0.23 | UJ+ | 0.05 | 0.10 | 0.20 | U | ND | * |
| PZ-204A-SS TOT | 8/2/2012 | 0.35 | 0.22 | 0.21 | J | 0.42 | 0.24 | 0.17 | J- | 0.06 | 0.10 | 0.16 | UJ | 0.77 | * |
| PZ-204-SS TOT | 8/3/2012 | 0.11 | 0.15 | 0.24 | UJ | 0.11 | 0.13 | 0.20 | UJ | 0.13 | 0.13 | 0.17 | UJ | ND | * |
| PZ-205-AS TOT | 8/3/2012 | 0.15 | 0.15 | 0.22 | UJ | 0.15 | 0.13 | 0.11 | J | 0.07 | 0.09 | 0.11 | UΊ | 0.15 | * |
| PZ-205-SS TOT | 8/3/2012 | 0.18 | 0.21 | 0.27 | IJ | 2.76 | 1.01 | 0.21 | J- | -0.01 | 0.10 | 0.21 | UΊ | 2.76 | * |
| PZ-206-SS TOT | 8/7/2012 | 0.14 | 0.14 | 0.19 | UJ | 0.41 | 0.22 | 0.15 | J | 0.07 | 0.09 | 0.11 | UJ | 0.41 | * |
| PZ-207-AS TOT | 8/8/2012 | 0.08 | 0.14 | 0.24 | U | 0.23 | 0.21 | 0.24 | U | 0.00 | 0.12 | 0.29 | U | ND | * |
| PZ-208-SS TOT | 8/2/2012 | 0.07 | 0.10 | 0.16 | U | 0.47 | 0.25 | 0.12 | J+ | 0.06 | 0.10 | 0.18 | U | 0.47 | * |
| PZ-302-AI TOT | 8/9/2012 | 0.11 | 0.14 | 0.23 | U | 0.29 | 0.20 | 0.21 | J | 0.06 | 0.10 | 0.17 | U | 0.29 | * |
| PZ-303-AS TOT | 8/10/2012 | 0.02 | 0.10 | 0.24 | U | 0.44 | 0.28 | 0.27 | J | 0.19 | 0.17 | 0.18 | j | 0.62 | * |
| PZ-304-AI TOT | 8/10/2012 | 0.18 | 0.15 | 0.18 | UJ | 0.38 | 0.20 | 0.11 | J- | -0.01 | 0.05 | 0.13 | UJ | 0.38 | * |

Page 3 of 7 12/14/2012

Table 7: Summary of Thorium Isotope Results from OU-1 Additional Groundwater Sampling

| | | | Thorium | | FINAL | | Thorium | | FINAL | İ | Thorium | | FINAL | TOTAL THORIUI | M- |
|---------------|-------------|--------|---------|------|-------|--------|---------|------|-------|--------|---------|------|-------|------------------|-------|
| Sample ID | Sample Date | Result | CSU | MDA | Q | Result | CSU | MDA | Q | Result | CSU | MDA | Q | 228 + 230 + | + 232 |
| PZ-304-AS TOT | 8/10/2012 | 0.13 | 0.15 | 0.22 | U | 0.21 | 0.16 | 0.16 | J- | -0.01 | 0.05 | 0.14 | U | 0.21 | * |
| PZ-305-AI TOT | 8/8/2012 | 0.61 | 0.27 | 0.12 | J | 0.71 | 0.30 | 0.11 | J | 0.63 | 0.27 | 0.12 | J | 1.94 | |
| | | | | | | | | | | | | | | 0.00 | |
| S-5 DIS | 8/14/2012 | 0.06 | 0.11 | 0.20 | U | -0.04 | 0.07 | 0.22 | UJ+ | -0.05 | 0.07 | 0.23 | U | ND | * |
| S-8 DIS | 8/9/2012 | -0.01 | 0.07 | 0.15 | U | 0.09 | 0.11 | 0.14 | U | 0.06 | 0.09 | 0.14 | U | ND | * |
| S-10 DIS | 8/8/2012 | 0.05 | 0.10 | 0.19 | U | 0.28 | 0.21 | 0.15 | J | 0.07 | 0.12 | 0.22 | U | 0.28 | * |
| S-61 DIS | 8/7/2012 | -0.03 | 0.09 | 0.24 | UJ | 0.20 | 0.15 | 0.15 | J | 0.00 | 0.05 | 0.16 | UJ | 0.20 | * |
| S-82 DIS | 8/10/2012 | 0.02 | 0.06 | 0.14 | U | 0.18 | 0.15 | 0.14 | J- | 0.08 | 0.11 | 0.14 | U | 0.18 | * |
| S-84 DIS | 8/6/2012 | 0.01 | 0.10 | 0.23 | UJ | 0.15 | 0.13 | 0.11 | J | 0.07 | 0.09 | 0.11 | UJ | 0.15 | * |
| I-4 DIS | 8/14/2012 | 0.23 | 0.21 | 0.26 | U | 0.55 | 0.32 | 0.20 | J+ | 1.48 | 0.56 | 0.23 | | 2.04 | * |
| I-9 DIS | 8/14/2012 | 0.00 | 0.14 | 0.33 | U | 0.06 | 0.13 | 0.23 | UJ+ | -0.04 | 0.08 | 0.23 | U | ND | * |
| I-9 DUP DIS | 8/14/2012 | 0.09 | 0.12 | 0.15 | U | 0.26 | 0.20 | 0.20 | J+ | -0.01 | 0.07 | 0.15 | U | 0.26 | * |
| I-11 DIS | 8/8/2012 | -0.01 | 0.08 | 0.17 | U | 0.22 | 0.19 | 0.17 | J | 0.03 | 0.08 | 0.17 | U | 0.22 | * |
| I-62 DIS | 8/9/2012 | 0.10 | 0.13 | 0.21 | UJ | 0.11 | 0.11 | 0.15 | UJ | 0.04 | 0.07 | 0.13 | UJ | ND | * |
| 1-65 DIS | 8/6/2012 | 0.03 | 0.10 | 0.21 | U | 0.03 | 0.07 | 0.14 | U | 0.06 | 0.10 | 0.14 | U | ND | * |
| 1-66 DIS | 8/10/2012 | -0.04 | 0.07 | 0.22 | UJ | 0.15 | 0.16 | 0.24 | UJ- | -0.01 | 0.06 | 0.16 | UJ | ND | * |
| 1-67 DIS | 8/10/2012 | 0.08 | 0.19 | 0.37 | U | 0.20 | 0.20 | 0.25 | UJ- | 0.15 | 0.18 | 0.26 | U | ND | * |
| 1-68 DIS | 8/6/2012 | 0.04 | 0.11 | 0.22 | U | 0.36 | 0.24 | 0.15 | J | -0.06 | 0.08 | 0.26 | U | 0.36 | * |
| I-73 DIS | 8/4/2012 | 0.03 | 0.07 | 0.14 | U | 0.33 | 0.23 | 0.20 | J | 0.03 | 0.07 | 0.14 | U | 0.33 | * |
| D-3 DIS | 8/8/2012 | 0.13 | 0.15 | 0.20 | U | 0.07 | 0.11 | 0.20 | U | -0.03 | 0.08 | 0.25 | U | ND | * |
| D-3 DUP DIS | 8/8/2012 | 0.09 | 0.12 | 0.19 | U | 0.20 | 0.17 | 0.16 | J | 0.03 | 0.09 | 0.18 | U | 0.20 | * |
| D-6 DIS | 8/7/2012 | 0.22 | 0.25 | 0.32 | UJ | 0.24 | 0.27 | 0.36 | UJ | 0.10 | 0.17 | 0.29 | UJ | ND | * |
| D-6 DUP DIS | 8/7/2012 | 0.09 | 0.14 | 0.24 | U | 0.20 | 0.20 | 0.27 | U | 0.02 | 0.07 | 0.17 | U | ND | * |
| D-12 DIS | 8/8/2012 | -0.01 | 0.09 | 0.18 | UJ | 0.34 | 0.25 | 0.18 | J | -0.01 | 0.09 | 0.18 | UJ | 0.34 | * |
| D-13 DIS | 8/10/2012 | 0.07 | 0.11 | 0.18 | UJ | 0.27 | 0.20 | 0.19 | J | 0.03 | 0.08 | 0.18 | IJ | 0.27 | * |
| D-13 DUP DIS | 8/10/2012 | 0.03 | 0.08 | 0.17 | UJ | 0.33 | 0.21 | 0.17 | J- | 0.00 | 0.08 | 0.21 | UJ | 0.33 | * |
| D-81 DIS | 8/9/2012 | 0.02 | 0.12 | 0.27 | U | 0.16 | 0.14 | 0.15 | J | 0.00 | 0.08 | 0.17 | U | 0.16 | * |
| D-83 DIS | 8/9/2012 | 0.15 | 0.22 | 0.36 | UJ | 0.03 | 0.11 | 0.28 | UJ | 0.03 | 0.11 | 0.28 | UJ | ND | * |

Page 4 of 7 12/14/2012

Table 7: Summary of Thorium Isotope Results from OU-1 Additional Groundwater Sampling

| | | | Thorium | 1-228 | FINAL | | Thorium | 1-230 | FINAL | | Thorium | 1-232 | FINAL | TOTAL THORIUM- |
|----------------|-------------|--------|---------|-------|-------|--------|---------|-------|------------|--------|---------|-------|-------|-------------------|
| Sample ID | Sample Date | Result | CSU | MDA | Q | Result | CSU | MDA | Q | Result | CSU | MDA | Q | 228 + 230 + 232 |
| D-85 DIS | 8/6/2012 | -0.02 | 0.13 | 0.31 | UJ | 0.12 | 0.18 | 0.26 | UJ | 0.04 | 0.13 | 0.30 | UJ | ND * |
| D-87 DIS | 8/1/2012 | -0.05 | 0.10 | 0.36 | UJ | 0.88 | 0.44 | 0.21 | J+ | -0.01 | 0.09 | 0.19 | UJ | 0.88 * |
| D-93 DIS | 8/14/2012 | 0.16 | 0.16 | 0.23 | U | 0.46 | 0.23 | 0.11 | J+ | 0.03 | 0.07 | 0.15 | U | 0.46 * |
| LR-100 DIS | 8/13/2012 | 0.06 | 0.10 | 0.17 | UJ | 0.36 | 0.22 | 0.17 | J+ | 0.05 | 0.08 | 0.12 | UJ | 0.36 * |
| LR-103 DIS | 8/13/2012 | 0.05 | 0.09 | 0.14 | U | 0.27 | 0.19 | 0.18 | j + | 0.02 | 0.06 | 0.13 | U | 0.27 * |
| LR-104 DIS | 8/13/2012 | -0.02 | 0.07 | 0.19 | U | 0.24 | 0.19 | 0.19 | J+ | 0.05 | 0.09 | 0.17 | U | 0.24 * |
| LR-104 DUP DIS | 8/13/2012 | -0.02 | 0.08 | 0.25 | U | 0.26 | 0.20 | 0.19 | J+ | 0.06 | 0.09 | 0.15 | U | 0.26 * |
| LR-105 DIS | 8/1/2012 | 0.23 | 0.20 | 0.20 | J | 1.05 | 0.47 | 0.17 | J+ | -0.01 | 0.08 | 0.19 | UJ | 1.28 * |
| MW-102 DIS | 8/7/2012 | 0.20 | 0.29 | 0.47 | UJ | 0.24 | 0.28 | 0.36 | UJ | -0.03 | 0.14 | 0.36 | UJ | ND * |
| MW-103 DIS | 8/11/2012 | 0.06 | 0.10 | 0.18 | U | 0.30 | 0.20 | 0.17 | J- | 0.05 | 0.08 | 0.13 | U | 0.30 * |
| MW-104 DIS | 8/9/2012 | -0.03 | 0.10 | 0.28 | U | 0.27 | 0.20 | 0.19 | J | 0.02 | 0.09 | 0.20 | U | 0.27 * |
| MW-1204 DIS | 8/2/2012 | 0.15 | 0.71 | 1.65 | IJ | 0.23 | 0.69 | 1.48 | UJ- | 0.04 | 0.49 | 1.41 | UJ | ND * |
| PZ-100-KS DIS | 8/16/2012 | -0.01 | 0.06 | 0.15 | U | 0.20 | 0.16 | 0.17 | J+ | 0.00 | 0.08 | 0.17 | U | 0.20 * |
| PZ-100-SD DIS | 7/31/2012 | 0.12 | 0.18 | 0.30 | UJ | 0.91 | 0.45 | 0.27 | J | -0.04 | 0.09 | 0.26 | UJ | 0.91 * |
| PZ-100-SS DIS | 7/31/2012 | 0.08 | 0.16 | 0.30 | U | 1.11 | 0.47 | 0.16 | J | 0.01 | 0.08 | 0.22 | U | 1.11 * |
| PZ-101-SS DIS | 8/7/2012 | 0.06 | 0.09 | 0.13 | U | 0.34 | 0.22 | 0.19 | j | 0.03 | 0.09 | 0.19 | U | 0.34 * |
| PZ-102R-SS DIS | 8/13/2012 | 0.12 | 0.13 | 0.18 | U | 0.35 | 0.22 | 0.18 | J- | 0.03 | 0.11 | 0.22 | U | 0.35 * |
| PZ-102-SS DIS | 8/13/2012 | 0.05 | 0.09 | 0.18 | UJ | 0.68 | 0.29 | 0.13 | J+ | 0.03 | 0.07 | 0.15 | UJ | 0.68 * |
| PZ-103-SS DIS | 8/7/2012 | 0.01 | 0.13 | 0.30 | U | 0.15 | 0.17 | 0.25 | U | 0.00 | 0.10 | 0.21 | U | ND * |
| PZ-104-KS DIS | 8/13/2012 | 0.12 | 0.13 | 0.18 | U | 0.21 | 0.17 | 0.18 | j+ | 0.02 | 0.06 | 0.13 | U | 0.21 * |
| PZ-104-SD DIS | 8/1/2012 | 0.05 | 0.12 | 0.25 | UJ | 0.24 | 0.20 | 0.17 | J | 0.00 | 0.00 | 0.11 | UJ | 0.24 * |
| PZ-104-SS DIS | 8/1/2012 | 0.16 | 0.19 | 0.23 | UJ | 0.27 | 0.27 | 0.32 | UJ | 0.00 | 0.15 | 0.32 | UJ | ND * |
| PZ-105-SS DIS | 8/1/2012 | 0.13 | 0.18 | 0.29 | U | 0.98 | 0.45 | 0.23 | J+ | 0.05 | 0.11 | 0.22 | U | 0.98 * |
| PZ-106-KS DIS | 8/14/2012 | 0.04 | 0.09 | 0.19 | U | 0.25 | 0.18 | 0.14 | J+ | 0.05 | 0.09 | 0.16 | U | 0.25 * |
| PZ-106-SD DIS | 7/31/2012 | 0.08 | 0.09 | 0.11 | UJ | 0.07 | 0.09 | 0.14 | IJ | -0.01 | 0.05 | 0.16 | UJ | ND * |
| PZ-106-SS DIS | 7/31/2012 | 0.02 | 0.07 | 0.16 | U | 0.13 | 0.13 | 0.14 | UJ | 0.02 | 0.07 | 0.16 | U | ND * |
| PZ-107-SS DIS | 8/4/2012 | 0.14 | 0.13 | 0.12 | J | 0.13 | 0.12 | 0.12 | J | 0.08 | 0.10 | 0.12 | U | 0.27 * |
| PZ-109-SS DIS | 8/2/2012 | -0.07 | 0.06 | 0.24 | UJ | 0.06 | 0.09 | 0.14 | UJ- | -0.03 | 0.05 | 0.16 | UJ | ND * |

Page 5 of 7 12/14/2012

Table 7: Summary of Thorium Isotope Results from OU-1 Additional Groundwater Sampling

| Sample ID | Sample Date | | Thorium CSU | n-228 MDA | FINAL Q | Result | Thorium CSU | n-230 MDA | FINAL Q | Result | Thorium CSU | n-232 MDA | FINAL Q | TOTAI THORIU 228 + 230 - | M- |
|--------------------|-------------|-------|----------------|--------------|------------|--------|----------------|--------------|------------|--------|----------------|--------------|------------|--------------------------------|----|
| PZ-110-SS DIS | 8/2/2012 | -0.04 | 0.06 | 0.22 | UJ | 0.11 | 0.13 | 0.19 | UJ- | 0.00 | 0.07 | 0.15 | UJ | ND | * |
| PZ-110-33-DIS | 8/13/2012 | -0.02 | 0.07 | 0.22 | U | 0.11 | 0.20 | 0.19 | J+ | 0.03 | 0.09 | 0.19 | U | 0.26 | * |
| PZ-111-SD DIS | 8/1/2012 | 0.07 | 0.12 | 0.20 | U | 0.33 | 0.26 | 0.26 | J+ | 0.03 | 0.12 | 0.28 | U | 0.33 | * |
| PZ-112-AS DIS | 8/8/2012 | 0.03 | 0.09 | 0.20 | ΩΊ | 0.09 | 0.15 | 0.26 | UJ | -0.01 | 0.09 | 0.20 | UJ | ND | * |
| PZ-113-AD DIS | 8/3/2012 | 0.15 | 0.15 | 0.21 | ΠΊ | 0.16 | 0.14 | 0.12 | J | 0.01 | 0.06 | 0.16 | UJ | 0.16 | * |
| PZ-113-AD DUP DIS | 8/3/2012 | 0.02 | 0.06 | 0.14 | ΩJ | 0.19 | 0.16 | 0.18 | j | -0.04 | 0.06 | 0.19 | UJ | 0.19 | * |
| PZ-113-AS DIS | 8/8/2012 | 0.11 | 0.11 | 0.13 | ΟĴ | 0.13 | 0.13 | 0.13 | j | -0.01 | 0.06 | 0.13 | ÚJ | 0.13 | * |
| PZ-113-SS DIS | 8/4/2012 | 0.01 | 0.06 | 0.15 | U | 0.28 | 0.19 | 0.12 | J | 0.03 | 0.08 | 0.17 | U | 0.28 | * |
| PZ-114-AS DIS | 7/31/2012 | 0.12 | 0.20 | 0.34 | U | 0.52 | 0.32 | 0.31 | J | -0.02 | 0.08 | 0.27 | U | 0.52 | * |
| PZ-115-SS DIS | 7/31/2012 | 0.04 | 0.18 | 0.40 | UJ | 0.43 | 0.32 | 0.32 | J | -0.03 | 0.10 | 0.27 | UJ | 0.43 | * |
| PZ-116-SS DIS | 8/3/2012 | 0.01 | 0.09 | 0.21 | UJ | 0.35 | 0.21 | 0.17 | J | -0.02 | 0.06 | 0.16 | UJ | 0.35 | * |
| PZ-200-SS DIS | 8/2/2012 | 0.11 | 0.16 | 0.26 | U | 0.43 | 0.24 | 0.13 | J- | 0.06 | 0.09 | 0.13 | U | 0.43 | * |
| PZ-200-SS DUP DIS | 8/2/2012 | -0.03 | 0.07 | 0.24 | U | 0.18 | 0.15 | 0.13 | J- | -0.02 | 0.06 | 0.18 | U | 0.18 | * |
| PZ-201A-SS DIS | 8/1/2012 | -0.05 | 0.07 | 0.23 | U | 0.21 | 0.17 | 0.15 | J+ | 0.00 | 0.00 | 0.08 | U | 0.21 | * |
| | | | | | | | | | | | | | | | |
| PZ-201A-SS DUP DIS | 8/1/2012 | 0.09 | 0.12 | 0.17 | U | 0.17 | 0.14 | 0.12 | J+ | 0.04 | 0.10 | 0.20 | U | 0.17 | * |
| PZ-202-SS DIS | 8/2/2012 | 0.00 | 0.12 | 0.29 | U | 0.28 | 0.22 | 0.27 | J- | 0.02 | 0.10 | 0.23 | U | 0.28 | * |
| PZ-203-SS DIS | 8/1/2012 | 0.01 | 0.10 | 0.24 | UJ | 0.21 | 0.16 | 0.15 | J+ | 0.13 | 0.13 | 0.15 | UJ | 0.21 | * |
| PZ-204A-SS DIS | 8/2/2012 | -0.04 | 0.09 | 0.30 | U | 0.17 | 0.18 | 0.24 | UJ- | 0.08 | 0.13 | 0.20 | U | ND | * |
| PZ-204-SS DIS | 8/3/2012 | -0.05 | 0.08 | 0.30 | U | 0.19 | 0.17 | 0.18 | J | -0.02 | 0.07 | 0.18 | U | 0.19 | * |
| PZ-205-AS DIS | 8/3/2012 | 0.00 | 0.12 | 0.31 | U | 0.80 | 0.39 | 0.19 | | 0.03 | 0.08 | 0.16 | U | 0.80 | * |
| PZ-205-SS DIS | 8/3/2012 | 0.12 | 0.15 | 0.21 | UJ | 1.23 | 0.54 | 0.27 | J- | 0.03 | 0.12 | 0.29 | UJ | 1.23 | * |
| PZ-206-SS DIS | 8/7/2012 | 0.00 | 0.13 | 0.30 | U | 0.10 | 0.13 | 0.20 | U | -0.04 | 0.07 | 0.22 | U | ND | * |
| PZ-207-AS DIS | 8/8/2012 | 0.05 | 0.09 | 0.13 | U | 0.11 | 0.12 | 0.13 | U | -0.01 | 0.06 | 0.13 | U | ND | * |
| PZ-208-SS DIS | 8/2/2012 | -0.01 | 0.13 | 0.26 | UJ | 0.37 | 0.34 | 0.37 | J+ | 0.00 | 0.17 | 0.37 | UJ | 0.37 | * |
| PZ-302-AI DIS | 8/9/2012 | -0.04 | 0.07 | 0.23 | UJ | 0.19 | 0.15 | 0.15 | J | 0.01 | 0.06 | 0.15 | UJ | 0.19 | * |
| PZ-303-AS DIS | 8/10/2012 | 0.03 | 0.11 | 0.23 | UJ | 0.34 | 0.21 | 0.15 | J | 0.02 | 0.06 | 0.15 | UJ | 0.34 | * |
| PZ-304-AI DIS | 8/10/2012 | 0.09 | 0.13 | 0.22 | U | 0.37 | 0.23 | 0.17 | J- | 0.11 | 0.13 | 0.17 | U | 0.37 | * |

Page 6 of 7 12/14/2012

Table 7: Summary of Thorium Isotope Results from OU-1 Additional Groundwater Sampling

| | | | Thorium | 1-228 | | | Thorium | 1-230 | | 1 | Thorium | 1-232 | | TOTAL | |
|---------------|-------------|--------|---------|-------|-------|--------|---------|-------|-------|--------|---------|-------|-------|-------------|-----|
| | | | | | FINAL | | | | FINAL | | | | FINAL | THORIUM | 1- |
| Sample ID | Sample Date | Result | CSU | MDA | Q | Result | CSU | MDA | Q | Result | CSU | MDA | Q | 228 + 230 + | 232 |
| PZ-304-AS DIS | 8/10/2012 | -0.01 | 0.11 | 0.26 | υJ | 0.31 | 0.20 | 0.14 | j- | 0.03 | 0.08 | 0.16 | UJ | 0.31 | * |
| PZ-305-AI DIS | 8/8/2012 | -0.01 | 0.07 | 0.15 | U | 0.76 | 0.37 | 0.22 | j | -0.01 | 0.07 | 0.15 | U | 0.76 | * |

Notes:

All values are in units of picoCuries per liter (pCi/l)

DIS = dissolved sample (field filtered sample); TOT = total sample (unfiltered sample)

DUP = Duplicate samples; Field duplicates were collected from the following locations: DUP 01 = PZ-201A-SS, DUP 02 = PZ-200-SS,

DUP 03 = PZ-113-AD, DUP-04 = D-6, DUP-05 = D-3, DUP 06 = D-13, DUP 07 = LR-104, and DUP 08 = I-9.

CSU = Combined Standard Uncertainty (2-sigma); MDA = Minimum Detectable Activity

Data Validation Qualifiers (Final Q) include: U = Non-detect at the reported value;

UJ = Non-Detect at the estimated reported value; UJ+ = Non-Detect at the estimated reported value which may be biased high;

UJ- = Non-Detect at the estimated reported value which may be biased low;

J = estimated result; J+ = estimated result which may be biased high; J- = estimated result which may be biased low

Total Thorium - 228 + 230 +232 based on sum of detected values. ND indicates that results for all Thorium isotopes were non-detect and a * flag indicates that only one or two of the isotopes were detected.

Page 7 of 7 12/14/2012

Table 8: Summary of Radium Isotope Results from Additional OU-1 Groundwater Sampling

| | | l | | | | | | | | | | Combined | Combir | ned |
|----------------|---------|------------|--------|------|------|-------|------------|--------|------|------|-------|--------------|------------|---------|
| | Sample | | | | | FINAL | | | | | FINAL | Radium 226 - | Radium re | elative |
| Sample ID | Date | Analyte | Result | CSU | MDA | Q | Analyte | Result | CSU | MDA | Q | 228 | to 5 pCi/l | L MCL |
| S-5 TOT | 8/14/12 | Radium-226 | 0.67 | 0.61 | 0.63 | J | Radium-228 | 2.25 | 1.39 | 2.51 | UJ | 0.67 * | Less Thar | 1 MCL |
| S-8 TOT | 8/9/12 | Radium-226 | 0.65 | 0.35 | 0.26 | J | Radium-228 | 1.70 | 0.83 | 1.39 | J+ | 2.34 | Less Than | ı MCL |
| S-10 TOT | 8/8/12 | Radium-226 | 0.14 | 0.18 | 0.29 | U | Radium-228 | 0.55 | 0.60 | 1.19 | UJ | Non-Detect | Less Thar | 1 MCL |
| S-61 TOT | 8/7/12 | Radium-226 | 0.55 | 0.30 | 0.26 | J | Radium-228 | 0.80 | 0.68 | 1.30 | U | 0.55 * | Less Thar | 1 MCL |
| S-82 TOT | 8/10/12 | Radium-226 | 3.11 | 1.03 | 0.34 | | Radium-228 | 6.89 | 1.94 | 1.83 | J | 10.00 | Exceeds | MCL |
| S-84 TOT | 8/6/12 | Radium-226 | 1.29 | 0.52 | 0.25 | | Radium-228 | 1.98 | 0.95 | 1.59 | J | 3.26 | Less Thar | 1 MCL |
| I-4 TOT | 8/14/12 | Radium-226 | 2.83 | 0.98 | 0.39 | | Radium-228 | 3.68 | 1.45 | 2.15 | J | 6.51 | Exceeds | MCL |
| I-9 TOT | 8/14/12 | Radium-226 | 2.35 | 0.80 | 0.19 | | Radium-228 | 4.48 | 1.35 | 1.40 | | 6.83 | Exceeds | MCL |
| I-9 TOT (DUP) | 8/14/12 | Radium-226 | 2.22 | 0.75 | 0.18 | | Radium-228 | 3.81 | 1.36 | 1.84 | | 6.03 | Exceeds | MCL |
| I-11 TOT | 8/8/12 | Radium-226 | 1.31 | 0.52 | 0.22 | | Radium-228 | 3.55 | 1.11 | 1.26 | | 4.86 | Less Thar | n MCL |
| I-62 TOT | 8/9/12 | Radium-226 | 0.83 | 0.38 | 0.20 | J | Radium-228 | 0.75 | 0.68 | 1.33 | UJ+ | 0.83 * | Less Thar | n MCL |
| I-65 TOT | 8/6/12 | Radium-226 | 0.88 | 0.41 | 0.25 | | Radium-228 | 2.73 | 1.02 | 1.45 | J | 3.61 | Less Thar | n MCL |
| I-66 TOT | 8/10/12 | Radium-226 | 0.26 | 0.22 | 0.24 | J | Radium-228 | 1.24 | 0.82 | 1.51 | UJ | 0.26 * | Less Thar | n MCL |
| I-67 TOT | 8/10/12 | Radium-226 | 0.60 | 0.36 | 0.29 | J | Radium-228 | 0.46 | 0.69 | 1.41 | U | 0.60 * | Less Thar | n MCL |
| I-68 TOT | 8/6/12 | Radium-226 | 2.12 | 0.72 | 0.22 | | Radium-228 | 2.60 | 1.06 | 1.61 | J | 4.72 | Less Thar | 1 MCL |
| I-73 TOT | 8/4/12 | Radium-226 | 0.95 | 0.42 | 0.15 | | Radium-228 | 1.17 | 0.85 | 1.59 | U | 0.95 * | Less Thar | n MCL |
| D-3 TOT | 8/8/12 | Radium-226 | 4.17 | 1.29 | 0.35 | | Radium-228 | 6.05 | 1.66 | 1.42 | | 10.22 | Exceeds | MCL |
| D-3 TOT (DUP) | 8/8/12 | Radium-226 | 2.52 | 0.88 | 0.30 | J | Radium-228 | 4.13 | 1.21 | 1.27 | | 6.65 | Exceeds | MCL |
| D-6 TOT | 8/7/12 | Radium-226 | 3.39 | 1.05 | 0.23 | | Radium-228 | 4.76 | 1.38 | 1.31 | J | 8.15 | Exceeds | MCL |
| D-6 TOT (DUP) | 8/7/12 | Radium-226 | 3.26 | 1.03 | 0.26 | | Radium-228 | 3.24 | 1.11 | 1.46 | | 6.50 | Exceeds | MCL |
| D-12 TOT | 8/8/12 | Radium-226 | 0.80 | 0.39 | 0.25 | | Radium-228 | 1.13 | 0.63 | 1.10 | J | 1.93 | Less Thar | 1 MCL |
| D-13 TOT | 8/10/12 | Radium-226 | 1.41 | 0.54 | 0.23 | | Radium-228 | 4.49 | 1.35 | 1.45 | J+ | 5.90 | Exceeds | MCL |
| D-13 TOT (DUP_ | 8/10/12 | Radium-226 | 0.63 | 0.34 | 0.30 | j | Radium-228 | 2.04 | 0.94 | 1.52 | J | 2.67 | Less Thar | 1 MCL |
| D-14 TOT | 8/10/12 | Radium-226 | 2.18 | 0.75 | 0.33 | J | Radium-228 | 2.99 | 1.34 | 2.15 | J+ | 5.17 | Exceeds | MCL |
| D-81 TOT | 8/9/12 | Radium-226 | 0.63 | 0.33 | 0.21 | | Radium-228 | 3.41 | 1.10 | 1.26 | J+ | 4.03 | Less Thar | า MCL |
| D-83 TOT | 8/9/12 | Radium-226 | 2.80 | 0.93 | 0.25 | J | Radium-228 | 3.21 | 1.07 | 1.33 | J+ | 6.01 | Exceeds | MCL |
| D-85 TOT | 8/6/12 | Radium-226 | 6.84 | 1.92 | 0.31 | j | Radium-228 | 6.95 | 2.45 | 3.30 | J | 13.79 | Exceeds | MCL |
| D-87 TOT | 8/1/12 | Radium-226 | 1.70 | 0.60 | 0.24 | J+ | Radium-228 | 3.99 | 1.15 | 1.09 | J+ | 5.69 | Exceeds | MCL |
| D-93 TOT | 8/14/12 | Radium-226 | 1.22 | 0.53 | 0.23 | | Radium-228 | 1.81 | 0.97 | 1.68 | J | 3.03 | Less Thar | 1 MCL |
| LR-100 TOT | 8/13/12 | Radium-226 | 0.54 | 0.34 | 0.35 | J | Radium-228 | 1.06 | 1.01 | 1.97 | UJ | 0.54 * | Less Thar | 1 MCL |

Page 1 of 6 12/14/2012

Table 8: Summary of Radium Isotope Results from Additional OU-1 Groundwater Sampling

| | | | | | | | | | | | | Combine | d | Combined |
|------------------|---------|------------|--------|------|------|----------------|------------|--------|------|------|-------|-----------|-----|-----------------|
| | Sample | | | | | FINAL | | | | | FINAL | Radium 22 | 6 + | Radium relative |
| Sample ID | Date | Analyte | Result | CSU | MDA | Q | Analyte | Result | CSU | MDA | Q | 228 | | to 5 pCi/L MCL |
| LR-103 TOT | 8/13/12 | Radium-226 | 1.44 | 0.62 | 0.32 | | Radium-228 | 1.03 | 1.01 | 1.98 | UJ | 1.44 | * | Less Than MCL |
| LR-104 TOT | 8/13/12 | Radium-226 | 0.53 | 0.34 | 0.36 | j | Radium-228 | 2.14 | 1.00 | 1.65 | | 2.67 | | Less Than MCL |
| LR-104 TOT (DUP) | 8/13/12 | Radium-226 | 0.52 | 0.33 | 0.31 | J | Radium-228 | 1.16 | 0.77 | 1.41 | U | 0.52 | * | Less Than MCL |
| LR-105 TOT | 8/1/12 | Radium-226 | 0.91 | 0.44 | 0.29 | J+ | Radium-228 | 0.76 | 0.95 | 1.91 | UJ+ | 0.91 | * | Less Than MCL |
| MW-102 TOT | 8/7/12 | Radium-226 | 0.53 | 0.29 | 0.15 | j | Radium-228 | 1.31 | 0.80 | 1.45 | U | 0.53 | * | Less Than MCL |
| MW-103 TOT | 8/11/12 | Radium-226 | 5.44 | 1.57 | 0.37 | J | Radium-228 | 5.36 | 1.83 | 2.38 | J | 10.79 | | Exceeds MCL |
| MW-104 TOT | 8/9/12 | Radium-226 | 1.59 | 0.65 | 0.29 | J | Radium-228 | 3.34 | 1.44 | 2.26 | J+ | 4.93 | | Less Than MCL |
| MW-1204 TOT | 8/2/12 | Radium-226 | 4.24 | 1.24 | 0.21 | J | Radium-228 | 2.44 | 0.99 | 1.48 | | 6.68 | | Exceeds MCL |
| PZ-100-KS TOT | 8/16/12 | Radium-226 | 0.55 | 0.31 | 0.22 | J | Radium-228 | 0.70 | 1.04 | 2.13 | U | 0.55 | * | Less Than MCL |
| PZ-100-SD TOT | 7/31/12 | Radium-226 | 2.74 | 0.88 | 0.31 | | Radium-228 | 1.03 | 0.60 | 1.05 | U | 2.74 | * | Less Than MCL |
| PZ-100-SS TOT | 7/31/12 | Radium-226 | 2.95 | 0.89 | 0.21 | J | Radium-228 | 1.28 | 0.65 | 1.09 | J | 4.23 | | Less Than MCL |
| PZ-101-SS TOT | 8/7/12 | Radium-226 | 12.52 | 2.99 | 0.24 | J _. | Radium-228 | 3.68 | 1.11 | 1.17 | | 16.19 | | Exceeds MCL |
| PZ-102R-SS TOT | 8/13/12 | Radium-226 | 2.65 | 0.82 | 0.15 | J | Radium-228 | 1.87 | 0.76 | 1.14 | | 4.52 | | Less Than MCL |
| PZ-102-SS TOT | 8/13/12 | Radium-226 | 5.96 | 1.76 | 0.38 | J | Radium-228 | 3.42 | 1.52 | 2.43 | J | 9.38 | | Exceeds MCL |
| PZ-103-SS TOT | 8/7/12 | Radium-226 | 4.72 | 1.39 | 0.22 | | Radium-228 | 1.34 | 0.73 | 1.25 | J | 6.06 | | Exceeds MCL |
| PZ-104-KS TOT | 8/13/12 | Radium-226 | 0.17 | 0.18 | 0.20 | U | Radium-228 | 0.29 | 1.08 | 2.28 | UJ | Non-Detec | t | Less Than MCL |
| PZ-104-SD TOT | 8/1/12 | Radium-226 | 4.50 | 1.26 | 0.18 | | Radium-228 | 0.52 | 0.89 | 1.83 | U | 4.50 | * | Less Than MCL |
| PZ-104-SS TOT | 8/1/12 | Radium-226 | 1.62 | 0.57 | 0.14 | | Radium-228 | 1.47 | 0.79 | 1.35 | J | 3.09 | | Less Than MCL |
| PZ-105-SS TOT | 8/1/12 | Radium-226 | 1.84 | 0.62 | 0.18 | J+ | Radium-228 | 1.01 | 0.65 | 1.17 | UJ+ | 1.84 | * | Less Than MCL |
| PZ-106-KS TOT | 8/14/12 | Radium-226 | 0.23 | 0.24 | 0.33 | U | Radium-228 | 1.46 | 0.99 | 1.83 | UJ | Non-Detec | t | Less Than MCL |
| PZ-106-SD TOT | 7/31/12 | Radium-226 | 1.06 | 0.44 | 0.18 | | Radium-228 | 0.94 | 0.62 | 1.14 | U | 1.06 | * | Less Than MCL |
| PZ-106-SS TOT | 7/31/12 | Radium-226 | 3.93 | 1.13 | 0.18 | | Radium-228 | 1.27 | 0.70 | 1.22 | J | 5.20 | | Exceeds MCL |
| PZ-107-SS TOT | 8/4/12 | Radium-226 | 6.33 | 1.73 | 0.33 | | Radium-228 | 2.62 | 1.13 | 1.78 | J | 8.95 | | Exceeds MCL |
| PZ-109-SS TOT | 8/2/12 | Radium-226 | 2.58 | 0.83 | 0.22 | J | Radium-228 | 2.72 | 0.98 | 1.28 | J | 5.30 | | Exceeds MCL |
| PZ-110-SS TOT | 8/2/12 | Radium-226 | 4.38 | 1.18 | 0.21 | J | Radium-228 | 2.21 | 0.88 | 1.27 | | 6.59 | | Exceeds MCL |
| PZ-111-KS TOT | 8/13/12 | Radium-226 | 0.63 | 0.34 | 0.21 | J | Radium-228 | 0.96 | 0.84 | 1.62 | UJ | 0.63 | * | Less Than MCL |
| PZ-111-SD TOT | 8/1/12 | Radium-226 | 1.34 | 0.52 | 0.21 | J+ | Radium-228 | 0.34 | 0.70 | 1.45 | UJ+ | 1.34 | * | Less Than MCL |
| PZ-112-AS TOT | 8/8/12 | Radium-226 | 2.76 | 1.01 | 0.40 | J | Radium-228 | 2.86 | 1.03 | 1.42 | J | 5.62 | | Exceeds MCL |
| PZ-113-AS TOT | 8/8/12 | Radium-226 | 0.64 | 0.36 | 0.27 | | Radium-228 | 1.37 | 0.84 | 1.53 | U | 0.64 | * | Less Than MCL |
| PZ-113-SS TOT | 8/4/12 | Radium-226 | 1.91 | 0.67 | 0.21 | | Radium-228 | -0.32 | 0.88 | 1.91 | U | 1.91 | * | Less Than MCL |

Page 2 of 6 12/14/2012

Table 8: Summary of Radium Isotope Results from Additional OU-1 Groundwater Sampling

| | | | | | | | | | | | | Combine | d | Combined |
|---------------------|---------|------------|--------|------|------|-------|------------|--------|------|------|-------|-----------|-----|-----------------|
| | Sample | | | | | FINAL | | | | | FINAL | Radium 22 | 6 + | Radium relative |
| Sample ID | Date | Analyte | Result | CSU | MDA | Q | Analyte | Result | CSU | MDA | Q | 228 | | to 5 pCi/L MCL |
| PZ-113-AD TOT | 8/3/12 | Radium-226 | 3.41 | 1.19 | 0.44 | J | Radium-228 | 7.71 | 2.05 | 1.62 | J | 11.12 | | Exceeds MCL |
| PZ-113-AD TOT (DUP) | 8/3/12 | Radium-226 | 1.05 | 0.51 | 0.30 | J | Radium-228 | 1.01 | 0.68 | 1.26 | U | 1.05 | * | Less Than MCL |
| PZ-114-AS TOT | 7/31/12 | Radium-226 | 0.41 | 0.25 | 0.22 | J | Radium-228 | 0.82 | 0.78 | 1.52 | UJ | 0.41 | * | Less Than MCL |
| PZ-115-SS TOT | 7/31/12 | Radium-226 | 6.20 | 1.63 | 0.21 | | Radium-228 | 0.59 | 0.64 | 1.28 | U | 6.20 | * | Exceeds MCL |
| PZ-116-SS TOT | 8/3/12 | Radium-226 | 0.54 | 0.32 | 0.23 | J | Radium-228 | 0.83 | 0.67 | 1.28 | U | 0.54 | * | Less Than MCL |
| PZ-200-SS TOT | 8/2/12 | Radium-226 | 4.94 | 1.42 | 0.37 | J | Radium-228 | 2.80 | 1.01 | 1.37 | | 7.74 | | Exceeds MCL |
| PZ-200-SS TOT (DUP) | 8/2/12 | Radium-226 | 4.69 | 1.32 | 0.23 | J | Radium-228 | 1.95 | 0.90 | 1.46 | | 6.65 | | Exceeds MCL |
| PZ-201A-SS TOT | 8/1/12 | Radium-226 | 0.31 | 0.22 | 0.20 | J+ | Radium-228 | 0.87 | 0.67 | 1.27 | UJ+ | 0.31 | * | Less Than MCL |
| PZ-201A-SS TOT (DUP | 8/1/12 | Radium-226 | 0.29 | 0.17 | 0.09 | J+ | Radium-228 | 1.40 | 0.77 | 1.33 | J+ | 1.69 | | Less Than MCL |
| PZ-202-SS TOT | 8/2/12 | Radium-226 | 1.97 | 0.70 | 0.24 | J | Radium-228 | 2.61 | 1.02 | 1.47 | | 4.58 | | Less Than MCL |
| PZ-203-SS TOT | 8/1/12 | Radium-226 | 0.95 | 0.40 | 0.25 | J+ | Radium-228 | 1.89 | 0.72 | 1.01 | J+ | 2.84 | | Less Than MCL |
| PZ-204A-SS TOT | 8/2/12 | Radium-226 | 2.34 | 0.78 | 0.21 | J | Radium-228 | 0.19 | 0.93 | 1.97 | UJ | 2.34 | * | Less Than MCL |
| PZ-204-SS TOT | 8/3/12 | Radium-226 | 1.10 | 0.54 | 0.40 | | Radium-228 | 0.63 | 0.77 | 1.55 | U | 1.10 | * | Less Than MCL |
| PZ-205-AS TOT | 8/3/12 | Radium-226 | 1.20 | 0.51 | 0.28 | | Radium-228 | 1.51 | 0.82 | 1.43 | J | 2.70 | | Less Than MCL |
| PZ-205-SS TOT | 8/3/12 | Radium-226 | 1.73 | 0.64 | 0.24 | J | Radium-228 | 1.30 | 0.92 | 1.72 | UJ | 1.73 | * | Less Than MCL |
| PZ-206-SS TOT | 8/7/12 | Radium-226 | 1.44 | 0.52 | 0.22 | | Radium-228 | 1.12 | 0.72 | 1.31 | U | 1.44 | * | Less Than MCL |
| PZ-207-AS TOT | 8/8/12 | Radium-226 | 0.66 | 0.36 | 0.24 | J | Radium-228 | 2.50 | 0.89 | 1.20 | | 3.16 | | Less Than MCL |
| PZ-208-SS TOT | 8/2/12 | Radium-226 | 0.83 | 0.37 | 0.18 | J+ | Radium-228 | 0.26 | 0.76 | 1.58 | UJ+ | 0.83 | * | Less Than MCL |
| PZ-302-AI TOT | 8/9/12 | Radium-226 | 1.08 | 0.48 | 0.25 | | Radium-228 | 2.22 | 0.85 | 1.20 | J+ | 3.30 | | Less Than MCL |
| PZ-303-AS TOT | 8/10/12 | Radium-226 | 0.63 | 0.35 | 0.25 | J | Radium-228 | 3.82 | 1.32 | 1.75 | J+ | 4.46 | | Less Than MCL |
| PZ-304-AI TOT | 8/10/12 | Radium-226 | 1.52 | 0.69 | 0.51 | | Radium-228 | 4.84 | 1.34 | 1.12 | | 6.35 | | Exceeds MCL |
| PZ-304-AS TOT | 8/10/12 | Radium-226 | 2.19 | 0.84 | 0.35 | | Radium-228 | 3.38 | 1.13 | 1.39 | J | 5.56 | | Exceeds MCL |
| PZ-305-AI TOT | 8/8/12 | Radium-226 | 2.18 | 0.79 | 0.27 | | Radium-228 | 2.10 | 0.88 | 1.35 | J | 4.28 | | Less Than MCL |
| | | | | | | | | | | | | | | |
| S-5 DIS | 8/14/12 | Radium-226 | 1.29 | 0.85 | 0.90 | J | Radium-228 | 2.03 | 1.25 | 2.26 | UJ | 1.29 | * | Less Than MCL |
| S-8 DIS | 8/9/12 | Radium-226 | 0.56 | 0.32 | 0.25 | J | Radium-228 | 2.02 | 0.80 | 1.16 | J+ | 2.58 | | Less Than MCL |
| S-10 DIS | 8/8/12 | Radium-226 | 0.06 | 0.13 | 0.25 | U | Radium-228 | 0.67 | 0.61 | 1.18 | IJ | Non-Detec | t | Less Than MCL |
| S-61 DIS | 8/7/12 | Radium-226 | 0.35 | 0.23 | 0.20 | J | Radium-228 | 1.26 | 0.72 | 1.25 | J | 1.61 | | Less Than MCL |
| S-82 DIS | 8/10/12 | Radium-226 | 1.32 | 0.57 | 0.31 | | Radium-228 | 6.08 | 1.72 | 1.62 | J | 7.40 | | Exceeds MCL |
| S-84 DIS | 8/6/12 | Radium-226 | 0.51 | 0.32 | 0.24 | J | Radium-228 | 1.67 | 1.02 | 1.83 | IJ | 0.51 | * | Less Than MCL |

Page 3 of 6 12/14/2012

Table 8: Summary of Radium Isotope Results from Additional OU-1 Groundwater Sampling

| | | I | | | | | 1 | | | | | Combined | ı | Combined |
|-------------------|---------|------------|--------|------|------|-------|------------|--------|------|------|-------|------------|--------------|-----------------|
| | Sample | | | | | FINAL | | | | | FINAL | Radium 226 | \downarrow | Radium relative |
| Sample ID | Date | Analyte | Result | CSU | MDA | Q | Analyte | Result | CSU | MDA | Q | 228 | 1 | to 5 pCi/L MCL |
| I-4 DIS | 8/14/12 | Radium-226 | 1.94 | 0.72 | 0.27 | | Radium-228 | 4.23 | 1.40 | 1.73 | | 6.17 | Ť | Exceeds MCL |
| I-9 DIS | 8/14/12 | Radium-226 | 2.14 | 0.76 | 0.20 | | Radium-228 | 4.21 | 1.40 | 1.75 | J | 6.34 | ı | Exceeds MCL |
| I-9 DIS (DUP) | 8/14/12 | Radium-226 | 2.38 | 0.80 | 0.18 | | Radium-228 | 5.06 | 1.59 | 1.82 | J | 7.44 | l | Exceeds MCL |
| I-11 DIS | 8/8/12 | Radium-226 | 1.01 | 0.45 | 0.22 | | Radium-228 | 2.99 | 1.03 | 1.34 | | 3.99 | 1 | Less Than MCL |
| I-62 DIS | 8/9/12 | Radium-226 | 0.32 | 0.22 | 0.20 | J | Radium-228 | 2.03 | 0.80 | 1.16 | J+ | 2.35 | ı | Less Than MCL |
| I-65 DIS | 8/6/12 | Radium-226 | 0.22 | 0.20 | 0.25 | U | Radium-228 | 0.96 | 0.73 | 1.38 | ίU | Non-Detect | ı | Less Than MCL |
| I-66 DIS | 8/10/12 | Radium-226 | 0.12 | 0.17 | 0.28 | UJ | Radium-228 | 0.46 | 0.73 | 1.49 | U | Non-Detect | ı | Less Than MCL |
| 1-67 DIS | 8/10/12 | Radium-226 | 0.55 | 0.33 | 0.27 | J | Radium-228 | 0.64 | 0.68 | 1.34 | U | 0.55 * | ۱ | Less Than MCL |
| I-68 DIS | 8/6/12 | Radium-226 | 0.52 | 0.30 | 0.23 | j | Radium-228 | 3.46 | 1.09 | 1.24 | | 3.98 | ı | Less Than MCL |
| I-73 DIS | 8/4/12 | Radium-226 | 0.71 | 0.39 | 0.27 | J | Radium-228 | 0.97 | 0.97 | 1.92 | UJ | 0.71 * | ۱, | Less Than MCL |
| D-3 DIS | 8/8/12 | Radium-226 | 2.55 | 0.91 | 0.31 | | Radium-228 | 5.06 | 1.50 | 1.54 | J | 7.61 | ı | Exceeds MCL |
| D-3 DIS (DUP) | 8/8/12 | Radium-226 | 3.06 | 1.06 | 0.39 | | Radium-228 | 6.72 | 1.74 | 1.15 | J | 9.78 | ı | Exceeds MCL |
| D-6 DIS | 8/7/12 | Radium-226 | 2.54 | 0.83 | 0.24 | | Radium-228 | 3.71 | 1.15 | 1.29 | J | 6.25 | ı | Exceeds MCL |
| D-6 DIS (DUP) | 8/7/12 | Radium-226 | 3.09 | 0.99 | 0.30 | J | Radium-228 | 3.81 | 1.12 | 1.09 | | 6.90 | 1 | Exceeds MCL |
| D-12 DIS | 8/8/12 | Radium-226 | 0.68 | 0.36 | 0.22 | | Radium-228 | 0.51 | 0.59 | 1.17 | UJ | 0.68 * | ۱, | Less Than MCL |
| D-13 DIS | 8/10/12 | Radium-226 | 1.21 | 0.49 | 0.17 | | Radium-228 | 2.19 | 0.90 | 1.36 | J+ | 3.40 | ı | Less Than MCL |
| D-13 DIS (DUP) | 8/10/12 | Radium-226 | 0.93 | 0.41 | 0.22 | J | Radium-228 | 5.34 | 1.46 | 1.21 | | 6.27 | ı | Exceeds MCL |
| D-81 DIS | 8/9/12 | Radium-226 | 0.62 | 0.33 | 0.19 | J | Radium-228 | 2.04 | 0.88 | 1.37 | j+ | 2.66 | ı | Less Than MCL |
| D-83 DIS | 8/9/12 | Radium-226 | 3.23 | 1.00 | 0.27 | | Radium-228 | 3.48 | 1.15 | 1.42 | J+ | 6.70 | | Exceeds MCL |
| D-85 DIS | 8/6/12 | Radium-226 | 1.65 | 0.65 | 0.28 | | Radium-228 | 2.80 | 1.04 | 1.45 | J | 4.45 | ı | Less Than MCL |
| D-87 DIS | 8/1/12 | Radium-226 | 1.42 | 0.56 | 0.20 | J+ | Radium-228 | 3.93 | 1.19 | 1.27 | J+ | 5.35 | | Exceeds MCL |
| D-93 DIS | 8/14/12 | Radium-226 | 1.79 | 0.66 | 0.25 | | Radium-228 | 3.45 | 1.34 | 2.00 | | 5.24 | | Exceeds MCL |
| LR-100 DIS | 8/13/12 | Radium-226 | 0.83 | 0.40 | 0.28 | | Radium-228 | 0.89 | 0.92 | 1.82 | UJ | 0.83 * | ۱ ا | Less Than MCL |
| LR-103 DIS | 8/13/12 | Radium-226 | 1.10 | 0.51 | 0.24 | | Radium-228 | 1.62 | 0.92 | 1.62 | J | 2.73 | 1 | Less Than MCL |
| LR-104 DIS | 8/13/12 | Radium-226 | 0.48 | 0.33 | 0.33 | J | Radium-228 | 1.62 | 0.86 | 1.49 | J | 2.10 | | Less Than MCL |
| LR-104 DIS (DUP) | 8/13/12 | Radium-226 | 0.71 | 0.37 | 0.25 | J | Radium-228 | 1.21 | 0.82 | 1.52 | ŲJ | 0.71 * | ۱. | Less Than MCL |
| LR-105 DIS | 8/1/12 | Radium-226 | 1.14 | 0.47 | 0.20 | J+ | Radium-228 | 1.81 | 0.83 | 1.34 | J+ | 2.95 | 1 | Less Than MCL |
| MW-102 DIS | 8/7/12 | Radium-226 | 0.86 | 0.41 | 0.24 | | Radium-228 | 0.68 | 0.67 | 1.31 | U | 0.86 * | ۱ ا | Less Than MCL |
| MW-103 DIS | 8/11/12 | Radium-226 | 0.27 | 0.21 | 0.21 | J | Radium-228 | 4.32 | 1.27 | 1.28 | | 4.59 | 1 | Less Than MCL |
| MW-104 DIS | 8/9/12 | Radium-226 | 0.46 | 0.29 | 0.19 | J | Radium-228 | 0.70 | 0.80 | 1.61 | UJ+ | 0.46 * | ۱' | Less Than MCL |

Page 4 of 6 12/14/2012

Table 8: Summary of Radium Isotope Results from Additional OU-1 Groundwater Sampling

| | | | | | | | | | | | | Combined | 1 | Combined |
|---------------------|---------|------------|--------|------|------|-------|------------|--------|------|------|-------|--------------|-----|-----------------|
| | Sample | | | | | FINAL | | | | | FINAL | Radium 226 - | + | Radium relative |
| Sample ID | Date | Analyte | Result | CSU | MDA | Q | Analyte | Result | CSU | MDA | Q | 228 | 1 | to 5 pCi/L MCL |
| MW-1204 DIS | 8/2/12 | Radium-226 | 2.79 | 0.88 | 0.27 | J | Radium-228 | 1.84 | 0.87 | 1.43 | | 4.63 | ł | Less Than MCL |
| PZ-100-KS DIS | 8/16/12 | Radium-226 | 0.21 | 0.21 | 0.25 | U | Radium-228 | -0.04 | 1.27 | 2.73 | UJ | Non-Detect | ı | Less Than MCL |
| PZ-100-SD DIS | 7/31/12 | Radium-226 | 2.69 | 0.87 | 0.28 | | Radium-228 | 0.37 | 0.67 | 1.37 | U | 2.69 * | ۱ | Less Than MCL |
| PZ-100-SS DIS | 7/31/12 | Radium-226 | 3.95 | 1.15 | 0.27 | | Radium-228 | 1.12 | 0.72 | 1.33 | Ų | 3.95 * | ۱ | Less Than MCL |
| PZ-101-SS DIS | 8/7/12 | Radium-226 | 28.87 | 6.55 | 0.24 | | Radium-228 | 3.13 | 1.10 | 1.47 | J | 32.01 | ı | Exceeds MCL |
| PZ-102R-SS DIS | 8/13/12 | Radium-226 | 3.62 | 1.08 | 0.25 | | Radium-228 | 1.69 | 0.88 | 1.52 | J | 5.32 | ı | Exceeds MCL |
| PZ-102-SS DIS | 8/13/12 | Radium-226 | 3.63 | 1.06 | 0.20 | J | Radium-228 | 2.12 | 0.89 | 1.38 | | 5.75 | 1 | Exceeds MCL |
| PZ-103-SS DIS | 8/7/12 | Radium-226 | 3.09 | 1.00 | 0.24 | | Radium-228 | 1.96 | 0.83 | 1.26 | J | 5.05 | | Exceeds MCL |
| PZ-104-KS DIS | 8/13/12 | Radium-226 | 0.28 | 0.23 | 0.24 | j | Radium-228 | 0.35 | 1.12 | 2.36 | UJ | 0.28 * | ۱ | Less Than MCL |
| PZ-104-SD DIS | 8/1/12 | Radium-226 | 9.74 | 2.73 | 0.46 | J | Radium-228 | 4.68 | 1.59 | 2.02 | J | 14.42 | | Exceeds MCL |
| PZ-104-SS DIS | 8/1/12 | Radium-226 | 1.60 | 0.58 | 0.21 | J | Radium-228 | 0.92 | 0.62 | 1.15 | UJ | 1.60 * | ۱ ٔ | Less Than MCL |
| PZ-105-SS DIS | 8/1/12 | Radium-226 | 1.92 | 0.65 | 0.28 | J+ | Radium-228 | 1.14 | 0.61 | 1.06 | J+ | 3.06 | | Less Than MCL |
| PZ-106-KS DIS | 8/14/12 | Radium-226 | 0.27 | 0.22 | 0.24 | J | Radium-228 | 0.46 | 0.81 | 1.66 | U | 0.27 * | ۱ ٔ | Less Than MCL |
| PZ-106-SD DIS | 7/31/12 | Radium-226 | 1.28 | 0.52 | 0.23 | | Radium-228 | 1.08 | 0.71 | 1.30 | Ų | 1.28 * | ۱ ٔ | Less Than MCL |
| PZ-106-SS-DIS | 7/31/12 | Radium-226 | 2.90 | 0.91 | 0.28 | | Radium-228 | 0.90 | 0.76 | 1.47 | U | 2.90 * | ۱ ۱ | Less Than MCL |
| PZ-107-SS DIS | 8/4/12 | Radium-226 | 5.02 | 1.39 | 0.22 | j | Radium-228 | 2.28 | 0.88 | 1.27 | | 7.30 | ı | Exceeds MCL |
| PZ-109-SS DIS | 8/2/12 | Radium-226 | 2.35 | 0.80 | 0.35 | j | Radium-228 | 2.06 | 0.90 | 1.43 | | 4.41 | 1 | Less Than MCL |
| PZ-110-SS DIS | 8/2/12 | Radium-226 | 5.01 | 1.36 | 0.19 | J | Radium-228 | 2.11 | 0.90 | 1.39 | | 7.13 | | Exceeds MCL |
| PZ-111-KS DIS | 8/13/12 | Radium-226 | 0.32 | 0.25 | 0.22 | J | Radium-228 | 0.09 | 0.76 | 1.61 | UJ | 0.32 * | ۱ | Less Than MCL |
| PZ-111-SD DIS | 8/1/12 | Radium-226 | 1.26 | 0.47 | 0.15 | J+ | Radium-228 | 1.37 | 0.86 | 1.57 | UJ+ | 1.26 * | ۱' | Less Than MCL |
| PZ-112-AS DIS | 8/8/12 | Radium-226 | 3.08 | 1.04 | 0.36 | | Radium-228 | 2.19 | 0.91 | 1.39 | | 5.27 | 1 | Exceeds MCL |
| PZ-113-AS DIS | 8/8/12 | Radium-226 | 0.73 | 0.42 | 0.39 | J | Radium-228 | 1.24 | 0.74 | 1.33 | U | 0.73 * | ۱ ٔ | Less Than MCL |
| PZ-113-SS DIS | 8/4/12 | Radium-226 | 1.94 | 0.64 | 0.15 | j | Radium-228 | 1.93 | 0.93 | 1.54 | | 3.87 | | Less Than MCL |
| PZ-113-AD DIS | 8/3/12 | Radium-226 | 4.51 | 1.40 | 0.31 | J | Radium-228 | 7.70 | 1.98 | 1.26 | | 12.20 | | Exceeds MCL |
| PZ-113-AD DIS (DUP) | 8/3/12 | Radium-226 | 1.21 | 0.56 | 0.24 | J | Radium-228 | 1.29 | 0.86 | 1.60 | UJ | 1.21 * | ۱ ا | Less Than MCL |
| PZ-114-AS DIS | 7/31/12 | Radium-226 | 0.72 | 0.36 | 0.19 | | Radium-228 | 1.59 | 0.84 | 1.45 | J | 2.30 | 1 | Less Than MCL |
| PZ-115-SS DIS | 7/31/12 | Radium-226 | 6.49 | 1.71 | 0.33 | | Radium-228 | 0.92 | 0.67 | 1.26 | U | 6.49 * | ۱, | Exceeds MCL |
| PZ-116-SS DIS | 8/3/12 | Radium-226 | 0.19 | 0.24 | 0.39 | UJ | Radium-228 | -0.14 | 0.68 | 1.47 | Ų | Non-Detect | | Less Than MCL |
| PZ-200-SS DIS | 8/2/12 | Radium-226 | 3.12 | 0.97 | 0.28 | J | Radium-228 | 3.03 | 1.07 | 1.44 | | 6.15 | | Exceeds MCL |
| PZ-200-SS DIS (DUP) | 8/2/12 | Radium-226 | 4.50 | 1.28 | 0.17 | J | Radium-228 | 1.20 | 0.91 | 1.73 | UJ | 4.50 * | ۱ | Less Than MCL |

Page 5 of 6 12/14/2012

Table 8: Summary of Radium Isotope Results from Additional OU-1 Groundwater Sampling

| | | | | | | | | | | | | Combine | - | Combined |
|----------------------|---------|------------|--------|------|------|-------|------------|--------|------|------|-------|-----------|------|-----------------|
| | Sample | | | | | FINAL | | | | | FINAL | Radium 22 | 26 + | Radium relative |
| Sample ID | Date | Analyte | Result | CSU | MDA | Q | Analyte | Result | CSU | MDA | Q | 228 | | to 5 pCi/L MCL |
| PZ-201A-SS DIS | 8/1/12 | Radium-226 | 0.45 | 0.27 | 0.23 | J+ | Radium-228 | 0.80 | 0.67 | 1.29 | UJ+ | 0.45 | * | Less Than MCL |
| PZ-201A-SS DIS (DUP) | 8/1/12 | Radium-226 | 0.15 | 0.15 | 0.18 | UJ+ | Radium-228 | 1.57 | 0.84 | 1.45 | j+ | 1.57 | * | Less Than MCL |
| PZ-202-SS DIS | 8/2/12 | Radium-226 | 0.67 | 0.37 | 0.28 | J | Radium-228 | 2.02 | 0.91 | 1.46 | | 2.69 | | Less Than MCL |
| PZ-203-SS DIS | 8/1/12 | Radium-226 | 1.08 | 0.45 | 0.23 | J+ | Radium-228 | 0.95 | 0.67 | 1.24 | UJ+ | 1.08 | * | Less Than MCL |
| PZ-204A-SS DIS | 8/2/12 | Radium-226 | 0.72 | 0.37 | 0.24 | J | Radium-228 | 1.48 | 0.84 | 1.48 | J | 2.20 | | Less Than MCL |
| PZ-204-SS DIS | 8/3/12 | Radium-226 | 1.41 | 0.62 | 0.35 | | Radium-228 | 1.02 | 0.82 | 1.58 | UJ | 1.41 | * | Less Than MCL |
| PZ-205-AS DIS | 8/3/12 | Radium-226 | 1.33 | 0.57 | 0.24 | J | Radium-228 | 0.88 | 0.76 | 1.47 | U | 1.33 | * | Less Than MCL |
| PZ-205-SS DIS | 8/3/12 | Radium-226 | 1.54 | 0.59 | 0.22 | J | Radium-228 | 1.46 | 0.82 | 1.45 | J | 3.00 | | Less Than MCL |
| PZ-206-SS DIS | 8/7/12 | Radium-226 | 0.91 | 0.40 | 0.20 | | Radium-228 | 1.56 | 0.76 | 1.26 | J | 2.47 | | Less Than MCL |
| PZ-207-AS DIS | 8/8/12 | Radium-226 | 0.73 | 0.38 | 0.26 | J | Radium-228 | 0.97 | 0.71 | 1.33 | U | 0.73 | * | Less Than MCL |
| PZ-208-SS DIS | 8/2/12 | Radium-226 | 0.52 | 0.27 | 0.14 | J+ | Radium-228 | 1.90 | 0.88 | 1.41 | J+ | 2.42 | | Less Than MCL |
| PZ-302-AI DIS | 8/9/12 | Radium-226 | 0.47 | 0.29 | 0.25 | J | Radium-228 | 1.42 | 0.70 | 1.17 | j+ | 1.90 | | Less Than MCL |
| PZ-303-AS DIS | 8/10/12 | Radium-226 | 0.36 | 0.23 | 0.20 | J | Radium-228 | 2.44 | 1.26 | 2.15 | j+ | 2.80 | | Less Than MCL |
| PZ-304-AI DIS | 8/10/12 | Radium-226 | 1.93 | 0.76 | 0.35 | J | Radium-228 | 2.76 | 1.01 | 1.44 | | 4.69 | | Less Than MCL |
| PZ-304-AS DIS | 8/10/12 | Radium-226 | 1.61 | 0.68 | 0.32 | | Radium-228 | 2.46 | 0.95 | 1.36 | J | 4.07 | | Less Than MCL |
| PZ-305-AI DIS | 8/8/12 | Radium-226 | 0.70 | 0.43 | 0.42 | J | Radium-228 | 0.27 | 0.72 | 1.50 | UJ | 0.70 | * | Less Than MCL |

Notes:

All values are in units of picoCuries per liter (pCi/l)

DIS = dissolved sample (field filtered sample); TOT = total sample (unfiltered sample)

DUP = Duplicate samples; Field duplicates were collected from the following locations: DUP 01 = PZ-201A-SS, DUP 02 = PZ-200-SS,

DUP 03 = PZ-113-Ad, DUP-04 = D-6, DUP-05 = D-3, DUP 06 = D-13, DUP 07 = LR-104, and DUP 08 = I-9.

CU = Counting Uncertainty; CSU = Combined Standard Uncertainty (2-sigma); MDA = Minimum Detectable Activity

Data Validation Qualifiers (Final Q) include: U = Non-detect at the reported value,

UJ = Non-Detect at the estimated reported value, UJ+ = Non-Detect at the estimated reported value which may be biased high,

J = estimated result; J+ = estimated result which may be biased high

Combined Radium-226 plus Radium-228 = the sum of the Ra-226 and Ra-228 results unless one of results was non-detect, in which case only the detected result is shown and the value is flagged with a *.

Non-Detect = neither Radium-226 nor Radium-228 were detected in the sample

MCL = Maximum Contaminant Level for drinking water systems of 5 pCi/l for total Radium-226 plus Radium-228

Page 6 of 6 12/14/2012

Table 9: Summary of Average, Median and Maximum Radium Results

Alluvial Monitoring Wells

| | Radio | um-226 | Radio | um-228 | Combined Ra | dium 226 + 228 |
|----------------------------|-------|-----------|-------|-----------|-------------|----------------|
| | Total | Dissolved | Total | Dissolved | Total | Dissolved |
| | | | | - | | |
| No. of Detects | 45 | 42 | 34 | 29 | 45 | 42 |
| No. Non-Detects | 1 | 3 | 12 | 16 | 1 | 3 |
| Total No. of Samples | 46 | 45 | 46 | 45 | 46 | 45 |
| Detection Frequency | 98% | 93% | 74% | 64% | 98% | 93% |
| Mean | 1.74 | 1.35 | 3.57 | 3.46 | 4.44 | 3.73 |
| Median | 1.29 | 0.97 | 3.36 | 3.45 | 4.28 | 3.10 |
| Maximum Value | 6.84 | 4.51 | 7.71 | 7.70 | 13.79 | 12.20 |

Bedrock Monitoring Wells

| | Radiu | ım-226 | Radi | um-228 | Combined Ra | dium 226 + 228 |
|----------------------|----------|-----------|-------|-----------|-------------|----------------|
| | Total | Dissolved | Total | Dissolved | Total | Dissolved |
| | <u> </u> | | | | | |
| No. of Detects | 32 | 31 | 16 | 18 | 32 | 32 |
| No. Non-Detects | 2 | 3 | 18 | 16 | 2 | 2 |
| Total No. of Samples | 34 | 34 | 34 | 34 | 34 | 34 |
| Detection Frequency | 94% | 91% | 47% | 53% | 94% | 94% |
| Mean | 2.93 | 3.35 | 2.19 | 2.11 | 4.02 | 4.44 |
| Median | 2.16 | 1.94 | 2.08 | 1.94 | 2.97 | 2.95 |
| Maximum Value | 12.52 | 28.87 | 3.68 | 4.68 | 16.19 | 32.01 |

Table 10: Comparison of Radium-226 Results from Duplicate Samples

| | Total or | Sample | | | | | | | | Ra-226 = | Relative Percent Difference |
|----------------|-----------|---------|------------|--------|------|------|------|-------|---------|------------|-----------------------------------|
| Sample ID | Dissolved | Date | Analyte | Result | CU | CSU | MDA | Units | FINAL Q | Detect? | (%) |
| PZ-201A-SS TOT | Total | 8/1/12 | Radium-226 | 0.31 | 0.21 | 0.22 | 0.20 | pCi/l | J+ | Detect | 6.0 |
| DUP 01 TOT | Total | 8/1/12 | Radium-226 | 0.29 | 0.15 | 0.17 | 0.09 | pCi/l | J+ | Detect | |
| PZ-200-SS TOT | Total | 8/2/12 | Radium-226 | 4.94 | 0.96 | 1.42 | 0.37 | pCi/l | J | Detect | 5.1 |
| DUP 02 TOT | Total | 8/2/12 | Radium-226 | 4.69 | 0.87 | 1.32 | 0.23 | pCi/l | J | Detect | |
| PZ-113-AD TOT | Total | 8/3/12 | Radium-226 | 3.41 | 0.94 | 1.19 | 0.44 | pCi/l | J | Detect | 106.2 |
| DUP 03 TOT | Total | 8/3/12 | Radium-226 | 1.05 | 0.46 | 0.51 | 0.30 | pCi/l | J | Detect | |
| D-6 TOT | Total | 8/7/12 | Radium-226 | 3.39 | 0.77 | 1.05 | 0.23 | pCi/l | | Detect | 4.0 |
| DUP 04 TOT | Total | 8/7/12 | Radium-226 | 3.26 | 0.77 | 1.03 | 0.26 | pCi/l | | Detect | |
| D-3 TOT | Total | 8/8/12 | Radium-226 | 4.17 | 0.94 | 1.29 | 0.35 | pCi/l | | Detect | 49.4 |
| DUP 05 TOT | Total | 8/8/12 | Radium-226 | 2.52 | 0.70 | 0.88 | 0.30 | pCi/l | J | Detect | |
| D-13 TOT | Total | 8/10/12 | Radium-226 | 1.41 | 0.46 | 0.54 | 0.23 | pCi/l | | Detect | 76.8 |
| DUP 06 TOT | Total | 8/10/12 | Radium-226 | 0.63 | 0.32 | 0.34 | 0.30 | pCi/l | J | Detect | |
| LR-104 TOT | Total | 8/13/12 | Radium-226 | 0.53 | 0.32 | 0.34 | 0.36 | pCi/l | J | Detect | 2.7 |
| DUP 07 TOT | Total | 8/13/12 | Radium-226 | 0.52 | 0.31 | 0.33 | 0.31 | pCi/l | J | Detect | |
| I-9 TOT | Total | 8/14/12 | Radium-226 | 2.35 | 0.63 | 0.80 | 0.19 | pCi/l | | Detect | 5.7 |
| DUP 08 TOT | Total | 8/14/12 | Radium-226 | 2.22 | 0.59 | 0.75 | 0.18 | pCi/l | | Detect | |
| PZ-201A-SS DIS | Dissolved | 8/1/12 | Radium-226 | 0.45 | 0.26 | 0.27 | 0.23 | pCi/l | J+ | Detect | Non-Detect |
| DUP 01 DIS | Dissolved | 8/1/12 | Radium-226 | 0.15 | 0.14 | 0.15 | 0.18 | pCi/l | UJ+ | Non-Detect | |
| PZ-200-SS DIS | Dissolved | 8/2/12 | Radium-226 | 3.12 | 0.71 | 0.97 | 0.28 | pCi/l | J | Detect | 36.2 |
| DUP 02 DIS | Dissolved | 8/2/12 | Radium-226 | 4.50 | 0.85 | 1.28 | 0.17 | pCi/l | J | Detect | |
| PZ-113-AD DIS | Dissolved | 8/3/12 | Radium-226 | 4.51 | 1.02 | 1.40 | 0.31 | pCi/l | J | Detect | 115.3 |
| DUP 03 DIS | Dissolved | 8/3/12 | Radium-226 | 1.21 | 0.49 | 0.56 | 0.24 | pCi/l | J | Detect | |
| D-6 DIS | Dissolved | 8/7/12 | Radium-226 | 2.54 | 0.64 | 0.83 | 0.24 | pCi/l | | Detect | 19.6 |
| DUP 04 DIS | Dissolved | 8/7/12 | Radium-226 | 3.09 | 0.74 | 0.99 | 0.30 | pCi/l | J | Detect | |
| D-3 DIS | Dissolved | 8/8/12 | Radium-226 | 2.55 | 0.74 | 0.91 | 0.31 | pCi/l | | Detect | 18.0 |
| DUP 05 DIS | Dissolved | 8/8/12 | Radium-226 | 3.06 | 0.84 | 1.06 | 0.39 | pCi/l | | Detect | |
| D-13 DIS | Dissolved | 8/10/12 | Radium-226 | 1.21 | 0.42 | 0.49 | 0.17 | pCi/l | | Detect | 25.7 |
| DUP 06 DIS | Dissolved | 8/10/12 | Radium-226 | 0.93 | 0.36 | 0.41 | 0.22 | pCi/l | J | Detect | |
| LR-104 DIS | Dissolved | 8/13/12 | Radium-226 | 0.48 | 0.31 | 0.33 | 0.33 | pCi/l | J | Detect | 38.5 |
| DUP 07 DIS | Dissolved | 8/13/12 | Radium-226 | 0.71 | 0.34 | 0.37 | 0.25 | pCi/l | J | Detect | |
| I-9 DIS | Dissolved | 8/14/12 | Radium-226 | 2.14 | 0.61 | 0.76 | 0.20 | pCi/l | | Detect | 10.8 |
| DUP 08 DIS | Dissolved | 8/14/12 | Radium-226 | 2.38 | 0.62 | 0.80 | 0.18 | pCi/l | | Detect | |

Table 10: Comparison of Radium-226 Results from Duplicate Samples

Notes:

DUP = Duplicate samples; Field duplicates were collected from the following locations: DUP 01 = PZ-201A-SS, DUP 02 = PZ-200-SS, DUP 03 = PZ-113-AD, DUP-04 = D-6, DUP-05 = D-3, DUP 06 = D-13, DUP 07 = LR-104, and DUP 08 = I-9.

CU = Counting Uncertainty; CSU = Combined Standard Uncertainty (2-sigma); MDA = Minimum Detectable Activity Data Validation Qualifiers (Final Q) include:

J = estimated result

J+ = estimated result which may be biased high

UJ+ = Non-Detect at the estimated reported value which may be biased high

Table 11: Comparison of Radium-228 Results from Duplicate Samples

| | | | | | | | | | | | Relative Percent |
|----------------|-----------|---------|------------|--------|------|------|------|-------|---------|------------|---------------------|
| | Total or | Sample | | | | | | | | Ra228 = | Difference |
| Sample ID | Dissolved | Date | Analyte | Result | CU | CSU | MDA | Units | FINAL Q | Detect? | (%) |
| PZ-201A-SS TOT | Total | 8/1/12 | Radium-228 | 0.87 | 0.64 | 0.67 | 1.27 | pCi/l | UJ+ | Non-Detect | Non-Detect |
| DUP 01 TOT | Total | 8/1/12 | Radium-228 | 1.40 | 0.70 | 0.77 | 1.33 | pCi/l | J+ | Detect | |
| PZ-200-SS TOT | Total | 8/2/12 | Radium-228 | 2.80 | 0.79 | 1.01 | 1.37 | pCi/l | | Detect | 35.5 |
| DUP 02 TOT | Total | 8/2/12 | Radium-228 | 1.95 | 0.79 | 0.90 | 1.46 | pCi/l | | Detect | |
| PZ-113-AD TOT | Total | 8/3/12 | Radium-228 | 7.71 | 1.07 | 2.05 | 1.62 | pCi/l | J | Detect | Non-Detect |
| DUP 03 TOT | Total | 8/3/12 | Radium-228 | 1.01 | 0.64 | 0.68 | 1.26 | pCi/l | U | Non-Detect | |
| D-6 TOT | Total | 8/7/12 | Radium-228 | 4.76 | 0.86 | 1.38 | 1.31 | pCi/l | J | Detect | 38.0 |
| DUP 04 TOT | Total | 8/7/12 | Radium-228 | 3.24 | 0.83 | 1.11 | 1.46 | pCi/l | | Detect | |
| D-3 TOT | Total | 8/8/12 | Radium-228 | 6.05 | 0.93 | 1.66 | 1.42 | pCi/l | | Detect | 37.7 |
| DUP 05 TOT | Total | 8/8/12 | Radium-228 | 4.13 | 0.77 | 1.21 | 1.27 | pCi/l | | Detect | |
| D-13 TOT | Total | 8/10/12 | Radium-228 | 4.49 | 0.89 | 1.35 | 1.45 | pCi/l | J+ | Detect | 75.0 |
| DUP 06 TOT | Total | 8/10/12 | Radium-228 | 2.04 | 0.82 | 0.94 | 1.52 | pCi/l | J | Detect | |
| LR-104 TOT | Total | 8/13/12 | Radium-228 | 2.14 | 0.88 | 1.00 | 1.65 | pCi/l | | Detect | Non-Detect |
| DUP 07 TOT | Total | 8/13/12 | Radium-228 | 1.16 | 0.73 | 0.77 | 1.41 | pCi/l | U | Non-Detect | |
| I-9 TOT | Total | 8/14/12 | Radium-228 | 4.48 | 0.89 | 1.35 | 1.40 | pCi/l | | Detect | 16.1 |
| DUP 08 TOT | Total | 8/14/12 | Radium-228 | 3.81 | 1.04 | 1.36 | 1.84 | pCi/l | | Detect | |
| PZ-201A-SS DIS | Dissolved | 8/1/12 | Radium-228 | 0.80 | 0.65 | 0.67 | 1.29 | pCi/l | UJ+ | Non-Detect | Non-Detect |
| DUP 01 DIS | Dissolved | 8/1/12 | Radium-228 | 1.57 | 0.76 | 0.84 | 1.45 | pCi/l | J+ | Detect | |
| PZ-200-SS DIS | Dissolved | 8/2/12 | Radium-228 | 3.03 | 0.83 | 1.07 | 1.44 | pCi/l | | Detect | Non-Detect |
| DUP 02 DIS | Dissolved | 8/2/12 | Radium-228 | 1.20 | 0.87 | 0.91 | 1.73 | pCi/l | UJ | Non-Detect | |
| PZ-113-AD DIS | Dissolved | 8/3/12 | Radium-228 | 7.70 | 0.93 | 1.98 | 1.26 | pCi/l | | Detect | Non-Detect |
| DUP 03 DIS | Dissolved | 8/3/12 | Radium-228 | 1.29 | 0.81 | 0.86 | 1.60 | pCi/l | UJ | Non-Detect | |
| D-6 DIS | Dissolved | 8/7/12 | Radium-228 | 3.71 | 0.79 | 1.15 | 1.29 | pCi/l | J | Detect | 2.8 |
| DUP 04 DIS | Dissolved | 8/7/12 | Radium-228 | 3.81 | 0.71 | 1.12 | 1.09 | pCi/l | | Detect | |
| D-3 DIS | Dissolved | 8/8/12 | Radium-228 | 5.06 | 0.96 | 1.50 | 1.54 | pCi/l | J | Detect | 28.1 |
| DUP 05 DIS | Dissolved | 8/8/12 | Radium-228 | 6.72 | 0.84 | 1.74 | 1.15 | pCi/l | J | Detect | |
| D-13 DIS | Dissolved | 8/10/12 | Radium-228 | 2.19 | 0.75 | 0.90 | 1.36 | pCi/l | _ J+ | Detect | 83.6 |
| DUP 06 DIS | Dissolved | 8/10/12 | Radium-228 | 5.34 | 0.81 | 1.46 | 1.21 | pCi/l | | Detect | |
| LR-104 DIS | Dissolved | 8/13/12 | Radium-228 | 1.62 | 0.78 | 0.86 | 1.49 | pCi/l | J | Detect | Non-Detect |
| DUP 07 DIS | Dissolved | 8/13/12 | Radium-228 | 1.21 | 0.78 | 0.82 | 1.52 | pCi/l | UJ | Non-Detect | |
| I-9 DIS | Dissolved | 8/14/12 | Radium-228 | 4.21 | 1.02 | 1.40 | 1.75 | pCi/l | J | Detect | 18.5 |
| DUP 08 DIS | Dissolved | 8/14/12 | Radium-228 | 5.06 | 1.10 | 1.59 | 1.82 | pCi/l | J | Detect | |

Table 11: Comparison of Radium-228 Results from Duplicate Samples

Notes:

DUP = Duplicate samples; Field duplicates were collected from the following locations: DUP 01 = PZ-201A-SS, DUP 02 = PZ-200-SS, DUP 03 = PZ-113-AD, DUP-04 = D-6, DUP-05 = D-3, DUP 06 = D-13, DUP 07 = LR-104, and DUP 08 = I-9.

CU = Counting Uncertainty; CSU = Combined Standard Uncertainty (2-sigma); MDA = Minimum Detectable Activity Data Validation Qualifiers (Final Q) include:

J = estimated result

J+ = estimated result which may be biased high

U = non-detect at the reported value

UJ = non-detect at the estimated reported value

UJ+ = non-Detect at the estimated reported value which may be biased high

Table 12: Comparison of Radium Results from OU-1 and MDNR Split Samples

| | | | | OU-1 Results | | | | | MDNR R | esults | j | |
|-----------------|-----------|--------|-------------|--------------|------|--------|-----------|--------|--------|--------|-----------|------------|
| | | | | Combined | | | | | | | | Relative |
| Sample | Sample | Lab | Counting | Sample | | Final | | | | | | Percent |
| Location | Fraction | Result | Uncertainty | Uncertainty | MDA | Result | Qualifier | Result | Error | MDA | Qualifier | Difference |
| Radium-226 | | | | | | | | | | | | |
| I- 9 | Total | 2.35 | 0.63 | 0.80 | 0.19 | 2.35 | | 2.32 | 0.59 | 0.20 | | 1.1% |
| | Dissolved | 2.14 | 0.61 | 0.76 | 0.20 | 2.14 | | 3.08 | 0.88 | 0.38 | | 36.2% |
| Dup-08 (I-9) | Total | 2.22 | 0.59 | 0.75 | 0.18 | 2.22 | | | | | | |
| | Dissolved | 2.38 | 0.62 | 0.80 | 0.18 | 2.38 | | | | | | |
| D-93 | Total | 1.22 | 0.46 | 0.53 | 0.23 | 1.22 | | 2.52 | 0.68 | 0.21 | | 69.3% |
| | Dissolved | 1.79 | 0.55 | 0.66 | 0.25 | 1.79 | | 1.50 | 0.52 | 0.24 | | 17.8% |
| S-5 | Total | 0.67 | 0.59 | 0.61 | 0.63 | 0.67 | J | 0.81 | 0.53 | 0.44 | J | 18.6% |
| | Dissolved | 1.29 | 0.81 | 0.85 | 0.90 | 1.29 | J | 2.25 | 1.22 | 0.96 | | 53.9% |
| 1-4 | Total | 2.83 | 0.78 | 0.98 | 0.39 | 2.83 | | 2.33 | 0.60 | 0.22 | | 19.3% |
| | Dissolved | 1.94 | 0.60 | 0.72 | 0.27 | 1.94 | | 3.15 | 0.77 | 0.30 | | 47.4% |
| PZ-106-KS | Total | 0.23 | 0.23 | 0.24 | 0.33 | 0.33 | U | 0.43 | 0.24 | 0.21 | J | Non-Detect |
| Lab Dup | Total | 0.42 | 0.29 | 0.31 | 0.29 | 0.42 | J | 0.47 | 0.27 | 0.25 | J | 11.2% |
| | Dissolved | 0.27 | 0.22 | 0.22 | 0.24 | 0.27 | J | 0.43 | 0.25 | 0.20 | J | 45.0% |
| | | | | | | | | | | | | |
| Radium-228 | | | | | | | | | | | | |
| I-9 | Total | 4.48 | 0.89 | 1.35 | 1.40 | 4.48 | | 3.96 | 0.86 | 1.46 | | 12.4% |
| | Dissolved | 4.21 | 1.02 | 1.40 | 1.75 | 4.21 | J | 4.59 | 0.96 | 1.62 | | 8.7% |
| Dup-08 (I-9) | Total | 3.81 | 1.04 | 1.36 | 1.84 | 3.81 | | | | | | |
| | Dissolved | 5.06 | 1.10 | 1.59 | 1.82 | 5.06 | J | | | | | |
| D-93 | Total | 1.81 | 0.88 | 0.97 | 1.68 | 1.81 | J | 2.77 | 0.83 | 1.49 | | 42.0% |
| | Dissolved | 3.45 | 1.09 | 1.34 | 2.00 | 3.45 | | 3.56 | 0.80 | 1.34 | | 3.2% |
| S-5 | Total | 2.25 | 1.29 | 1.39 | 2.51 | 2.51 | UJ | 5.96 | 1.36 | 2.22 | | Non-Detect |
| | Dissolved | 2.03 | 1.17 | 1.25 | 2.26 | 2.26 | υJ | 2.98 | 1.37 | 2.59 | J | Non-Detect |
| 1-4 | Total | 3.68 | 1.19 | 1.45 | 2.15 | 3.68 | J | 4.48 | 0.88 | 1.46 | | 19.6% |
| | Dissolved | 4.23 | 1.02 | 1.40 | 1.73 | 4.23 | | 3.11 | 0.89 | 1.60 | | 30.4% |
| PZ-106-KS | Total | 1.46 | 0.93 | 0.99 | 1.83 | 1.83 | UJ | 1.61 | 0.60 | 1.09 | J | Non-Detect |
| Lab Dup | Total | 0.027 | 1.08 | 1.08 | 2.30 | 2.30 | υ | 1.23 | 0.59 | 1.12 | j | Non-Detect |
| • | Dissolved | 0.46 | 0.80 | 0.81 | 1.66 | 1.66 | υ | 2.96 | 0.86 | 1.56 | | Non-Detect |

Table 12: Comparison of Radium Results from OU-1 and MDNR Split Samples

Notes:

All values are in units of picoCuries per liter (pCi/l)
DUP = Duplicate sample; The field duplicate DUP 08 = I-9.
MDA = Minimum Detectable Activity
Data Validation Qualifiers (Final Q) include:
U = Non-detect at the reported value
J = Estimated result
UJ = Non-Detect at the estimated reported value

Table 13: Summary of 2012 Radium-226 Results to Prior RI/FS Results

| | T . | Nov 1995 | | T | F | eb 199 | 16 | \neg | | May 1 | 996 | - | Fe | b - Ma | r 1997 | \neg | Ma | v - lur | ne 1997 | | | Mar 20 | 004 | | | May : | 2004 | | | 201 | 2 | |
|------------------|--------------|--|---------------|-------------|---------|--------|-------|---------------------|--------|-------|--------------|---------|--------------|--|--|----------|--------|----------------|------------|--------------|-------------|--|----------------|---------------|--|--|--------------|------------|---------|------|----------|------------|
| Sample ID | | CSU N | |) Resu | | | | n | | | | Π'n | | | | ᆔ | | | | Ω | | | | l o | | | | In | Result | | MDA | |
| Sumple 18 | Nesuit | C30 10 | IDA | I nesu | + | 230 | IVIDA | | nesure | 230 | 10107 | + | Result | | WIDA | Ť | AC3UIT | | IVIDA | - | Nesuit | | 14107 | + | , resore | 1 | 11102 | , <u>u</u> | ricsarc | 030 | IVIOA | |
| S-S TOT | 31.5 | 3 | 1.5 | J 0.6 | + | | | H | 0.23 | | | +- | | | | \dashv | | | | \vdash | | | | + | | \vdash | | + | 0.67 | 0.61 | 0.63 | |
| S-8 TOT | 57.8 | | 7.8 | | _ | | | 1 | 0.37 | | | + | | | | ┪ | | | | T | | | | \top | | | | т | 0.65 | 0.35 | | |
| S-10 TOT | 38.8 | | 8.8 | | | | 0.37 | u | 0.34 | | | | <u> </u> | | † | ┪ | | | | Т | | | | \dagger | | | | П | 0.14 | 0.18 | 0.29 | Ū |
| S-61 TOT | 30.6 | | 0.6 | | _ | | | H | 0.29 | | - | + | | | | T | | | | | | | 1 | + | • | 1 | 1 | \Box | 0.55 | 0.30 | | Ī |
| S-82 TOT | 25.1 | | 5.1 | | -+- | | | \vdash | 1.39 | | | + | | | | ┪ | 1.06 | 0.17 | 0.11 | + | | | + | + | | | + | ++ | 3.11 | | 0.34 | ŕ |
| S-82 TOT (DUP) | - 25.1 | | .5.1 | 7 1.0. | + | | | H | 1.55 | | | + | l - | · · - | | \dashv | 0.76 | 0.14 | 0.14 | \vdash | | | | + | | \vdash | | + | 3.11 | 1.03 | 0.54 | |
| S-84 TOT | 30.3 | 1 | 0.3 | 0.64 | 1 | | | \vdash | 0.34 | | | + | 1 | 1 | | \dashv | 0.70 | 0.27 | 0.14 | +- | | - | | +- | | - | + | $^{+1}$ | 1.29 | 0.52 | 0.25 | |
| S-84 TOT (DUP) | 33.5 | + | 3.5 | | + | | | H | 0.54 | | | + | | <u> </u> | | \dashv | | | | \vdash | | | 1 | + | 1 | + | 1 | \forall | 1.23 | 0.52 | 0.23 | |
| I-4 TOT | 25.4 | | 5.4 | | \perp | | | ┝╌╂ | 1.5 | | | + | l | | | ┪ | 1.04 | 0.14 | 0.058 | \vdash | | | | ╁╴ | | † | | \Box | 2.83 | 0.98 | 0.39 | |
| 1-4 TOT (DUP) | 29.6 | | | U 2.72 | + | | | + | | | | +- | | | | \dashv | 1.0 1 | 0.2 1 | 0.000 | \vdash | | | | + | <u>† </u> | t | 1 | Н | 2.03 | 0.50 | 0.55 | |
| I-9 TOT | 25.1 | | 5.1 | - | | | | | 0.64 | | | +- | | - | | \dashv | | | | \vdash | | | | + | † | 1 | 1 | + | 2.35 | 0.80 | 0.19 | |
| I-9 TOT (DUP) | 1 23.1 | | | 1.00 | - | | | \vdash | 0.04 | | | + | | | | \dashv | | | | \vdash | | | - | +- | | <u> </u> | _ | + | 2.22 | 0.75 | | |
| I-11 TOT | 34.9 | 2 | 4.9 | 0.85 | + | | | Н | 0.59 | | | + | | | | \dashv | | - | — — | + | | | | ╁ | | + | + | + | 1.31 | 0.52 | 0.22 | |
| I-62 TOT | 14.2 | - | | 0.37 | | | | \vdash | 0.35 | | | + | | - | | \dashv | | | | \vdash | | | + | + | † | 1 | + | + | 0.83 | 0.38 | 0.20 | J |
| 1-65 TOT | 24.6 | | \rightarrow | U 0.79 | - | | | | 0.15 | | 0.15 | +- | | - | | \dashv | | | | \vdash | | | | + | 1 | + | + | + | 0.88 | 0.41 | 0.25 | |
| 1-66 TOT | 28.2 | + | - | 0.57 | - | | | H | 0.13 | | 0.18 | - | | | | \dashv | | | | + | | | + | + | | + | + | + | 0.26 | 0.22 | 0.23 | j |
| I-66 TOT (DUP) | 20.2 | 2 | .6.2 | 0.48 | | - | | \vdash | 0.16 | | 0.10 | 10 | | | | \dashv | | | | + | | ļ | | + | | \vdash | + | ╁┤ | 0.20 | 0.22 | 0.24 | ⊢ ∸ |
| | 70 5 | | 0.5 | + | - | | | \vdash | 0.22 | | | +- | | - | - | \dashv | | | | + | | | - | + | | 1 | + | + | 0.60 | 0.26 | 0.29 | J |
| I-67 TOT | 28.5 | | 8.5 7.7 | U 0.54 | -+- | | | \vdash | 0.22 | | | + | ļ | | | \dashv | | | - | \vdash | | | - | + | 1 | + | + | + | | 0.36 | _ | , |
| I-68 TOT | 27.7 | 2 | :7.7 | U 0.72 | - | | | H | 0.66 | | | + | <u> </u> | | ļ | \dashv | | | | ⊢ | | | ├ | + | <u> </u> | | | + | 2.12 | 0.72 | 0.22 | |
| I-68 TOT (DUP) | + | + | - | | | | | \vdash | 0.6 | | | + | | | | \dashv | | | - | ╁ | | - | - | ┿ | | + | | + | 0.05 | 0.42 | 0.15 | |
| I-73 TOT | 1 20.4 | | | | -+- | | | H | | | - | + | ļ.—— | | | \dashv | 1.50 | 0.10 | 0.000 | + | | | 1 | + | 1 | 1 | + | + | 0.95 | _ | _ | |
| D-3 TOT (DUD) | 28.1 | 2 | 8.1 | U 2.7 | + | | | 1 | 1.19 | | | + | | | | - | 1.50 | 0.19 | 0.089 | \vdash | | | - | ╁ | 1 | - | 1 | + | 4.17 | 1.29 | 0.35 | |
| D-3 TOT (DUP) | | — | | | .+ | | | \vdash | 1.21 | | | + | - | | | | 3.05 | 0.33 | 0.053 | +- | <u> </u> | | | +- | - | | | + | 2.52 | 0.88 | 0.30 | |
| D-6 TOT | 28.2 | 2 | 8.2 | 1.78 | - | | | \vdash | 1.88 | | | + | - | | | \dashv | 2.05 | 0.23 | 0.053 | - | | | | + | 1 | 1 | + | Н | 3.39 | 1.05 | 0.23 | |
| D-6 TOT (DUP) | 16.4 | <u> </u> | <u> </u> | | + | | | \vdash | 0.73 | | | + | 1 | - | | | 0.54 | 0.00 | 0.077 | \vdash | | | | + | 1 | + | + | + | 3.26 | 1.03 | 0.26 | - |
| D-12 TOT | 16.1 | | 6.1 | | | | | Н | 0.73 | | | + | | | | \dashv | 0.54 | 0.09 | 0.077 | \vdash | | | | + | | 1 | + | + | 0.80 | 0.39 | 0.25 | |
| D-13 TOT | 30.2 | 3 | 10.2 | U 1.33 | 5 | | | Н | 0.86 | | | + | | | - | - | | - | | - | | | ₩- | +- | | | | + | 1.41 | 0.54 | 0.23 | |
| D-13 TOT (DUP) | | | - | + | + | | | Н | | | | + | | | | - | | ļ | | H | | | | + | ļ | - | + | + | 0.63 | 0.34 | 0.30 | 1 |
| D-14 TOT | 69.8 | | | 1.5 | + | | | Н | | | | + | | | | - | | | | \vdash | | | - | + | - | ₩ | + | + | 2.18 | 0.75 | 0.33 | J |
| D-81 TOT | | <u> </u> | -+ | | _ | | | \vdash | | | | + | | | | \dashv | | | | 1 | | - | | + | <u> </u> | - | + | + | 0.63 | 0.33 | 0.21 | |
| D-83 TOT | 25.8 | | 5.8 | | -+- | | | \vdash | 0.81 | | <u> </u> | + | <u> </u> | | | \dashv | | | | + | | ļ | | + | <u> </u> | 1 | + | + | 2.80 | 0.93 | 0.25 | |
| D-85 TOT | 25.9 | | 5.9 | | • | | _ | Н | 0.16 | | <u> </u> | +- | | | - | | | | - | + | | ļ | <u> </u> | + | | ↓ _ | +. | \perp | 6.84 | 1.92 | 0.31 | J |
| D-85 TOT (DUP) | 27 | - | 27 | U | + | | | \vdash | | | <u> </u> | +- | - | | | \dashv | | ļ | | <u> </u> | | <u> </u> | ļ | + | - | ┼ | + | | | | | |
| D-87 TOT | | <u> </u> | | | \perp | | | \sqcup | 2.22 | | <u> </u> | + | | <u> </u> | | | | | | \vdash | | ļ | ļ | - | | | | + | 1.70 | 0.60 | _ | J+ |
| D-93 TOT | 26.5 | 2 | 6.5 | U 1.43 | _ | | | \sqcup | 2.09 | | - | + | - | | | - | 1.34 | 0.16 | 0.083 | \vdash | | - | - | + | | - | - | \vdash | 1.22 | 0.53 | 0.23 | \vdash |
| D-93 TOT (DUP) | | - | | 1.21 | 1 | | | $\vdash \downarrow$ | | | | + | - | | | 4 | | - | | \vdash | | | - | + | | - | - | \vdash | | 0.51 | | |
| LR-100 TOT | _ | | - | - | 4 | | | | | | ļ | +- | 2.63 | 1.12 | 1.31 | | | Ļ | | ┶ | | | - | + | - | ₩ | 4 | Н | 0.54 | 0.34 | 0.35 | J |
| LR-103 TOT | | | | | _ | | | Н | | | | +- | 4.81 | 1.27 | | _ | | | | | | ļ | - | | . | ₽. | | 4-4 | 1.44 | 0.62 | 0.32 | |
| LR-104 TOT | _ | \vdash | \rightarrow | _ | _ | | | \sqcup | | | ļ | + | 3.08 | 1.08 | 0.972 | 4 | | | | \vdash | | | - | + | | ₩ | + | 44 | 0.53 | 0.34 | 0.36 | 1 |
| LR-104 TOT (DUP) | | | \rightarrow | + | \perp | | | \sqcup | | | ļ | +- | 1.8 | 0.79 | 0.833 | | | | <u> </u> | 4 | L | | | + | | | | \vdash | 0.52 | 0.33 | 0.31 | L |
| LR-105 TOT | - | | | | \perp | | | \sqcup | | | | + | 3.67 | 1.24 | 1.2 | _ | | - | | \vdash | | - | - | \bot | | | | Н | 0.91 | 0.44 | 0.29 |]+ |
| MW-102 TOT | | \vdash | _ | 1 | \perp | | | \sqcup | | | <u> </u> | 1 | L | | | _ | L | | L | \downarrow | L | | 1 | ╁- | | | <u> </u> | Щ | 0.53 | 0.29 | 0.15 | J |
| MW-103 TOT | | | | + | _ | | | \sqcup | | | ļ | \perp | 0.899 | | 0.899 | U | 1.17 | 0.46 | 0.419 | 1 | | | | \perp | | 1 | | \perp | 5.44 | 1.57 | 0.37 | 1 |
| MW-103 TOT | | | _ | ļ | - | | | \sqcup | | | | + | 0.25 | 0.34 | | 4 | | - | | \vdash | 1 | | _ | \perp | - | - | + | 14 | | | <u> </u> | |
| MW-103 TOT (DUP) | | \perp | | + | 4 | | | \sqcup | | | | \perp | 0.15 | | 0.15 | U | 0.515 | - | 0.515 | U | | | | 1 | | | + | \perp | | | <u> </u> | |
| MW-104 TOT | | | | | | | | Ш | | | | 1. | | L . | | | L | L | | <u>.</u> | L | L | | L | L | L | 1. | | 1.59 | 0.65 | 0.29 | J |

12/14/2012

Table 13: Summary of 2012 Radium-226 Results to Prior RI/FS Results

| | 1 | Vov 19 | 195 | | | Feb 1 | 196 | | | Vay 19 | 996 | Fel | b - Mai | r 1997 | 1 | Ma | v - lun | ne 1997 | | Τ , | Mar 2 | 004 | _ | | Mav | 2004 | | - | 201 | 2 | \neg |
|--------------------------------|--|---------------|--|----------|--------|--------------|--------------|--------------|----------|----------|--------------|-------------|----------|----------|---------------|--------|----------|--------------|--------------|--|----------|--|------------------|---|--------------|-------------|----------|--------|------|------|---------------------|
| Sample ID | | | | J | | | | ī | | | MDA Q | | | MDA | $\overline{}$ | | | | 0 | Result | | | Jο | | | | 10 | Result | | MDA | |
| Jample 10 | Nesuit | C30 | IVIDA | 1 4 | Result | <u> </u> | IVIDA | <u>u</u> | Nesuit | C30 | IVIDA | Result | 0.30 | IVIDA | 픡 | Nesuit | <u> </u> | IVIDA | + | T | C30 | IVIDA | ' '' | Nesuit | 1 | TVIO | <u> </u> | resure | C30 | MIDA | H |
| MW-1204 TOT | | ļ | | + | | | | + | | | - | 3.56 | 0.95 | 0.7 | 1 | 2.36 | 1 | 1.21 | | <u> </u> | | | + | | + | | | 4.24 | 1.24 | 0.21 | J |
| MW-1204 TOT (DUP) | 1 | <u> </u> | | H | | | | † | | | | 1 | 0.50 | 1 | T | 0.938 | | 0.938 | Τū | † | | 1 | t | | | 1 | + | | | | |
| PZ-100-KS TOT | - | | | Н | | | + | + | | | | | | 1 - 1 | 寸 | 0.555 | | 0.550 | Ť | | | | 1 | | | + | | 0.55 | 0.31 | 0.22 | |
| PZ-100-KS TOT | - | | | + | | | | | | | | 2.5 | 0.92 | 1.05 | Ħ | 2.98 | 0.9 | 0.807 | + | | | | + | | + | + | + | 2.74 | 0.88 | | 一 |
| PZ-100-SS TOT | + | | | + | | | 1 | | | | | 3.85 | 0.98 | + + | + | 1.82 | 0.72 | | -+- | - | - | | + | | + | | + | 2.95 | 0.89 | | j |
| PZ-100-33 TOT | + | | - | + | | | + | ╁ | | | | 3.03 | 0.50 | 0.037 | \dashv | 1.02 | 0.72 | 0.031 | + | | | + | + | · · — · | + | + | | 12.52 | 2.99 | | i |
| PZ-101-33 TOT | + | | | + | | <u> </u> | | + | | | | 2.12 | 1.04 | 1.3 | \dashv | 2.06 | 0.59 | 0.426 | + | 1 | | | ╁ | | + | + | | 2.65 | 0.82 | 0.15 | |
| PZ-102K-33 TOT | | _ | | + | | 1 | | + | | | | 2.12 | 1.04 | 1.5 | \dashv | 2.00 | 0.55 | 0.420 | + | 1 | <u> </u> | | + | | +- | + | | 5.96 | 1.76 | | j |
| PZ-102-33 TOT | + | | 1 | | | | + | + | | | | | | 1 | - | | | ļ | + | | | 1 | ╁ | | + | + | | 4.72 | 1.39 | 0.22 | 一 |
| PZ-103-33 TOT | + | | | + | | - | + | + | | | | | | | _ | | | | + | | | | +- | | + | + | + | 0.17 | 0.18 | | U |
| PZ-104-KS TOT | | - | | + | | | 1 | + | | | | 3.26 | 0.87 | 0.678 | - | 1.03 | 0.67 | 0.985 | + | · | _ | | + | | + | + | + | 4.50 | 1.26 | | H. |
| PZ-104-3D TOT PZ-104-SS TOT | 1 | | | + | | | | | | | | 4.62 | 1.06 | + + | - | 1.53 | 0.67 | 0.857 | | - | | | + | | + | + - | + | 1.62 | _ | 0.14 | -1 |
| PZ-104-35 TOT | | | 1 | + | · | - | - | + | | | - | 4.62 | 1.00 | 0.816 | - | 1.33 | 0.07 | 0.837 | | ļ | | | ╁ | | + | + | | 1.84 | 0.62 | | J+ |
| ! | - | - | | | | - | - | + | | | | | | | - | | | 1 | + | | | - | + | 1 | ╁ | | + | 0.23 | 0.02 | 0.33 | U |
| PZ-106-KS TOT | - | | | \vdash | | | + | + | - | | | 4.39 | 1.16 | 1.1 | \dashv | 1.33 | 0.56 | 0.571 | + | | | + | + | | 1 | - | - | 1.06 | 0.44 | 0.33 | -Ŭ |
| PZ-106-SD TOT PZ-106-SS TOT | + | | - | + | | - | | ╁ | | | | 6.33 | 1.26 | 0.864 | \dashv | 2.8 | 0.79 | 0.571 | + | 1 | | - | + | | ╁╌ | | + | 3.93 | 1.13 | 0.18 | \vdash |
| PZ-106-35 TOT | - | | - | ╁┤ | 0.066 | ļ | 0.066 | 1 | | | | 0.33 | 1.20 | 0.864 | \dashv | 2.8 | 0.75 | 0.67 | + | | | | + | | | + | | 6.33 | 1.73 | 0.33 | |
| | - | | - | ╁╌┤ | 0.000 | | 0.066 | U | | <u> </u> | | - | - | | - | | | | + | | - | - | + | | + | + | + | 2.58 | 0.83 | 0.22 | |
| PZ-109-SS TOT | _ | - | - | + | | - | | + | | | | 4.03 | 1.05 | 0.643 | | 3.50 | 0.0 | 0.673 | +- | | | | + | | ╁╌ | | + | 4.38 | 1.18 | 0.22 | ار |
| PZ-110-SS TOT | | | | + | | - | | ╁ | | | | 4.92 | 1.05 | 0.642 | \dashv | 3.59 | 0.8 | 0.672 | | | | + | + | | + | + | + | 0.63 | 0.34 | 0.21 | 1 |
| PZ-111-KS TOT | + | | - | + | | | | + | | | | 4.57 | 0.00 | 0.004 | \dashv | | 0.50 | 0.677 | + | | | | + | | - | + | + | 1.34 | 0.52 | 0.21 | j+ |
| PZ-111-SD TOT | | ļ | - | + | | | | ╆ | | | | 1.57 | 0.68 | 0.804 | - | 1.31 | 0.58 | 0.677 | + | . . – | | | + | | - | | + | 2.76 | 1.01 | 0.40 | 1+ |
| PZ-112-AS TOT | + | - | | + | | - | 1 | + | | | | 2.56 | | 0.073 | - | 0.704 | 0.43 | 0.53 | + | | | | + | | + | _ | + | 0.64 | 0.36 | 0.40 | |
| PZ-113-AS TOT | | | | | | - | | +- | | | | 3.56 | 1.14 | 0.972 | | 0.794 | | 0.52 | | | - | + | + | <u> </u> | + | + | + | 1.91 | 0.56 | 0.21 | |
| PZ-113-SS TOT | + | | | Н | | 1 | | + | | | | 5.8 2.44 | 1.33 | 0.87 | _ | 0.895 | 0.42 | 0.485 | - | <u> </u> | | | ╀ | | ╁ | - | + | 3.41 | 1.19 | | |
| PZ-113-AD TOT | + | ļ | | \vdash | | | - | + | | | | | 1.11 | 1.36 | - | 2.31 | 0.8 | 0.673 | + | | | + - | + | | - | + | + | 1.05 | 0.51 | 0.30 | - |
| PZ-113-AD TOT (DUP) | + | | 1 | + | 0.50 | | 1 | + | 0.17 | | | 3.58 | 0.98 | 0.73 | - | | | | + | | | | + | | \vdash | + | + | 0.41 | 0.31 | | + |
| PZ-114-AS TOT | 27.2 | | 27.2 | Ψ | 0.68 | | | + | 0.17 | | | | | | \dashv | | - | - | + | <u> </u> | | - | + | | | + | +- | | 1.63 | 0.22 | \dashv |
| PZ-115-SS TOT | | | ļ. — | Н | | _ | - | H | | | | | | | - | | | | + | - | | | + | | - | | +-! | 6.20 | | | |
| PZ-116-SS TOT | 1 | ļ | ļ | +i | | | - | + | | | - | | | - | | | | | + | 1 | | - | + | - | - | - | + | 0.54 | 0.32 | 0.23 | 1 |
| PZ-200-SS TOT | _ | - | 1 | + | | - | | +- | | | | | | | - | | | ļ | +- | | - | | + | | + | | | 4.94 | 1.42 | 0.37 | 1 |
| PZ-200-SS TOT (DUP) | | - | | \vdash | | | - | + | | | | 2.50 | 0.07 | | - | | 0.00 | 0.040 | + | - | _ | | + | | | - | | 4.69 | - | 0.23 | |
| PZ-201A-SS TOT | _ | | | | | - | | - | | | | 2.69 | 0.87 | 0.87 | - | 2.71 | 0.83 | 0.843 | + | ļ — — | - | | ╁ | 1 | + | - | | 0.31 | 0.22 | 0.20 | J+ |
| PZ-201A-SS TOT (DUP) | | - | | | | | | - | | | | | | | - | | - | | + | ļ | | - | ╁ | <u> </u> | + | - | + | 0.29 | 0.17 | 0.09 | J+ |
| PZ-202-SS TOT | _ | ļ | | \perp | | | - | + | | | | | | - | 4 | | | | +- | ļ | | + | + | | - | - | | 1.97 | 0.70 | _ | 1 |
| PZ-203-SS TOT | | - | | \vdash | | | - | + | | | | | | 0.5 | - | | | 0 | + | - | | <u> </u> | + | - | + | | + | 0.95 | 0.40 | 0.25 | J+ |
| PZ-204A-SS TOT | | <u> </u> | | | | | ļ | + | | | | 1.92 | 0.73 | 0.802 | | 2.61 | 0.67 | 0.561 | \perp | | _ | | + | | - | - | | 2.34 | 0.78 | 0.21 | J |
| PZ-204-SS TOT | _ | 1 | | Ш | | | | + | | | | | <u> </u> | | \dashv | | ļ | | - | ļ | | | + | - | ┼ | | + | 1.10 | 0.54 | 0.40 | \vdash |
| PZ-205-AS TOT | | | | 4-4 | | ļ | | | | | | | | <u> </u> | - | | ļ | ļ | \perp | 1 | - | | ╀ | | ┼ | | - | 1.20 | 0.51 | 0.28 | + |
| PZ-205-SS TOT | <u> </u> | | | Ш | | | | 4 | | | | | | | _ | | | ļ. — | 4_ | ļ | | | 1 | | ↓. | | | 1.73 | 0.64 | 0.24 | J |
| PZ-206-SS TOT | _ | ļ | 1 | Ш | | | | \perp | | | L L | 2.02 | 0.86 | 0.98 | | 1.61 | 0.66 | 0.766 | \perp | 1 | <u> </u> | <u> </u> | \perp | <u> </u> | 1 | - | 4 | 1.44 | 0.52 | 0.22 | |
| PZ-207-AS TOT | 1 | | 1 | Ш | | <u> </u> | | \perp | | | | | | 1 | 4 | | L | | | ļ | <u> </u> | | \perp | ļ | 1 | _ | \perp | 0.66 | 0.36 | | 1 |
| PZ-208-SS TOT | \perp | | | Ш | | | _ | \perp | | | | 2.25 | 0.78 | 0.775 | _ | 1.61 | 0.56 | 0.469 | | ļ | _ | - | 1 | | | | 44 | 0.83 | 0.37 | 0.18 | J+ |
| PZ-302-AI TOT | 1 | | 1 | \perp | | | - | | | | | L | | | _ | | | | 1 | ļ | | | ╁- | ļ | 1 | _ | Ш | 1.08 | 0.48 | 0.25 | \sqcup |
| PZ-303-AS TOT | ↓ | | | Ш | | | <u> </u> | 1 | | | <u> </u> | 1.03 | 0.14 | . | _ | 2.13 | ļ | 2.13 | U | <u> </u> | ļ | - | _ | ļ | 1 | | \perp | 0.63 | 0.35 | 0.25 | J |
| PZ-303-AS TOT (DUP) | 4 | ļ | 1 | Ш | · | | | \perp | | <u> </u> | \vdash | 2.48 | 0.75 | 0.703 | _ | | ļ | L | 1 | l | | | 1 | ļ | 1 | | \perp | | | | \boldsymbol{oxed} |
| PZ-304-AI TOT | 1 | | | | | | ١ | L | L | | | 1.58 | 0.73 | 0.878 | | 0.7 | | 0.7 | U | ــــــــــــــــــــــــــــــــــــــ | L_ | ١ | |] | | | | 1.52 | 0.69 | 0.51 | |

2 of 5

Table 13: Summary of 2012 Radium-226 Results to Prior RI/FS Results

| | T 1 | lov 19 | 95 | | | Feb 19 | 96 | 7 | | May 19 | 996 | | Fe | b - Mai | r 1997 | | Ma | y - Jur | ne 1997 | | | Mar 20 | 004 | | 1 | Viay 2 | 004 | П | | 201 | 2 | |
|---------------------|----------|--------|------|---|--------|--------|--------|---|----------|--------|--------|----------|--------|---------|----------|---------|---------|---------|---------|----------|--------|--------|--------|----------|----------|--------------|----------|----------|--------|----------|----------|--|
| Sample ID | | | | O | Result | CSU | MDA | o | | | | O | Result | CSU | MDA | Ιo | | | | la | Result | CSU | MDA | O | | <u> </u> | | ᇷ | Result | CSU | MDA | 0 |
| | - Hessie | 050 | | | neson | | 101071 | | - Mesure | - | 101011 | | nesun | | 10.071 | + | 1100010 | | 10.07 | | | | 11.071 | <u> </u> | 1 | 1 | 10,071 | Ť | | 1000 | 10,071 | T |
| PZ-304-AI-TOT (DUP) | | | | Н | | | | H | | - | | | 1.89 | 0.73 | 0.762 | T | 1.56 | 0.65 | 0.559 | Ħ | | | | | | | | 1 | | | | |
| PZ-304-AS TOT | 1 | | | | | | | П | | | | | 2.2 | 0.74 | 0.688 | | 0.642 | 0.42 | 0.561 | 1 | | | 1 | - | i | | | | 2.19 | 0.84 | 0.35 | |
| PZ-305-AI TOT | | | | П | | | | | | | | \vdash | | | İ | | | | | | | | | t | | | | _ | 2.18 | 0.79 | 0.27 | T |
| | | | | П | | | | П | | | | П | | | | T | | | | | | | | | | 1 | | | | | | |
| S-5 DIS | 32.5 | | 32.5 | U | 41.7 | | 41.7 | U | 0.13 | | 0.13 | υ | | | | | | | | | 0.37 | | 0.37 | U | 0.25 | | 0.25 | U | 1.29 | 0.85 | 0.90 | J |
| S-8 DIS | 35.7 | | 35.7 | U | 32.2 | | 32.2 | U | 0.21 | | | | | | | | | | | | | | | | | | | | 0.56 | 0.32 | 0.25 | 1 |
| S-10 DIS | | | | | 29.2 | | 29.2 | U | 0.32 | | | | | | | | | | | | 0.22 | | 0.22 | U | 0.23 | 0.1 | 0.19 | | 0.06 | 0.13 | 0.25 | U |
| S-10 DIS (DUP) | | | | | | | | | | | | | | | | | | | | | Ĭ | | | | 0.45 | 0.25 | 0.31 | | | | | |
| S-61 DIS | 25.7 | | 25.7 | U | 28 | | 28 | U | 0.29 | | | | | | | | | | | | 0.25 | 0.16 | 0.22 | | 0.24 | | 0.24 | υ | 0.35 | 0.23 | 0.20 | J |
| S-82 DIS | 12.8 | | 12.8 | U | 39.2 | | 39.2 | U | 0.88 | | | | | | | | 1.07 | 0.14 | 0.062 | | 0.58 | 0.20 | 0.19 | | 0.50 | 0.2 | 0.16 | | 1.32 | 0.57 | 0.31 | |
| S-84 DIS | 28.8 | | 28.8 | U | 28.7 | | 28.7 | U | 0.34 | | | | | | | | | | | | 0.52 | | 0.52 | U | 0.63 | 0.24 | 0.25 | | 0.51 | 0.32 | 0.24 | J |
| S-84 DIS (DUP) | 23.2 | | 23.2 | C | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| I-4 DIS | 41.4 | | 41.4 | U | 37.8 | | 37.8 | U | 0.87 | | | | | | | | 0.81 | 0.11 | 0.058 | | 0.19 | | 0.19 | υ | 1.26 | 0.29 | 0.19 | | 1.94 | 0.72 | 0.27 | |
| I-4 DIS (DUP) | 28.3 | | 28.3 | U | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| I-9 DIS | 12.7 | | 12.7 | U | 31.1 | | 31.1 | U | 0.54 | | | | | | | | | | | | 1.60 | 0.31 | 0.14 | | 0.94 | 0.3 | 0.27 | | 2.14 | 0.76 | 0.20 | |
| I-9 DIS (DUP) | | | | | | | | П | | | | | | | | T | | | | | | | | | | | | | 2.38 | 0.80 | 0.18 | |
| I-11 DIS | 25.5 | | 25.5 | U | 28.5 | | 28.5 | U | 0.5 | | | | | | | | | | | | 0.59 | 0.20 | 0.20 | | 0.85 | 0.3 | 0.31 | | 1.01 | 0.45 | 0.22 | |
| I-62 DIS | 17.1 | | 17.1 | U | 26.6 | | 26.6 | U | 0.14 | | 0.14 | U | | | | | | | | | | | | | | | | | 0.32 | 0.22 | 0.20 | J |
| I-65 DIS | 23.3 | | 23.3 | C | 41.5 | | 41.5 | U | 0.44 | | 0.44 | C | | | | | | | | | | | | | | | | | 0.22 | 0.20 | 0.25 | υ |
| I-66 DIS | 31.3 | | 31.3 | C | 33.6 | | 33.6 | υ | 0.34 | | 0.34 | C | | | | | | | | | | | | | | | | | 0.12 | 0.17 | 0.28 | UJ |
| I-66 DIS (DUP) | | | | | 35.5 | | 35.5 | υ | | | | | | | | | | | | | | | | | | | | | | | | |
| I-67 DIS | 23.9 | | 23.9 | U | 42 | | 42 | U | 0.52 | | | | | | | | | | | | | | | | | | | • | 0.55 | 0.33 | 0.27 | J |
| I-68 DIS | 28.6 | | 28.6 | U | 36.5 | | 36.5 | U | 0.44 | | | | | | | | | | | | 0.38 | 0.19 | 0.22 | | 0.46 | 0.2 | 0.20 | | 0.52 | 0.30 | 0.23 | J |
| I-68 DIS (DUP) | | | | | | | | | 0.47 | | | | | | | | | | | | | | | | | | | | | | <u> </u> | <u></u> |
| I-73 DIS | | | | | | | | | | | | | | | | | | | L | | | | L | | L | <u> </u> | | | 0.71 | 0.39 | 0.27 | J |
| D-3 DIS | 39.8 | | 39.8 | U | 27.2 | | 27.2 | U | 0.78 | | | | | | | | 0.75 | 0.11 | 0.083 | | 2.47 | 0.44 | 0.22 | | 2.54 | 0.5 | 0.25 | ┙ | 2.55 | 0.91 | 0.31 | |
| D-3 DIS (DUP) | | | | | | | | | 1.17 | | | | | | | | | | | | | | | | | | | | 3.06 | 1.06 | 0.39 | |
| D-6 DIS | 28.6 | | 28.6 | U | 36.7 | | 36.7 | U | 1.66 | | | | | | | | 1.80 | 0.21 | 0.093 | | 2.61 | 0.49 | 0.26 | | 2.56 | 0.5 | 0.27 | | 2.54 | 0.83 | 0.24 | |
| D-6 DIS (DUP) | | | | | | | | Ш | | | L | | | L | L . | \perp | | | | | 2.08 | 0.40 | 0.18 | | | <u> </u> | | | 3.09 | 0.99 | 0.30 | J |
| D-12 DIS | 15.4 | | 15.4 | U | 44.7 | | 44.7 | U | 0.36 | | | | | | | | 0.49 | 0.12 | 0.14 | | 0.57 | 0.19 | 0.18 | | 0.65 | 0.2 | 0.21 | | 0.68 | 0.36 | 0.22 | <u> </u> |
| D-12 DIS (DUP) | | | | | | | | Ц | | | | | | | | | 0.26 | 0.09 | 0.11 | | | | | | | | | | | | | |
| D-13 DIS | 23.9 | | 23.9 | U | 24.6 | | 24.6 | U | 0.58 | | | Ш | | | | ┶ | | | | Ш | 1.0 | 0.29 | 0.24 | <u> </u> | 1.26 | 0.3 | 0.14 | _ | 1.21 | 0.49 | | ļ |
| D-13 DIS (DUP) | | | | | | | | Ц | | | | | | | | | | | | | | | | | | | | | 0.93 | 0.41 | 0.22 | J |
| D-14 DIS | 31.3 | | 31.3 | U | 96.7 | | | Ц | | | | | | | | | | | | | | | | ļ | | 1 | | _ | | <u> </u> | | <u> </u> |
| D-81 DIS | | | | | | | | Ц | | | | | | | | | | | | Ш | | | | | | | | _ | 0.62 | - | 0.19 | J |
| D-83 DIS | 14 | | 14 | U | 30.5 | | 30.5 | U | 0.82 | | | Ш | | | ļ | \perp | | | ļ | Ш | | | | | | ļ | | _ | 3.23 | + | 0.27 | igspace |
| D-85 DIS | 31.4 | | 31.4 | + | 54.4 | L | 54.4 | U | 0.54 | | | Ц | | | <u> </u> | \perp | | | | Ш | 0.50 | 0.26 | 0.30 | \perp | 0.52 | 0.2 | 0.23 | _ | 1.65 | 0.65 | 0.28 | ــــــــــــــــــــــــــــــــــــــ |
| D-85 DIS (DUP) | 33.9 | | 33.9 | U | | | | Ц | | | | Ш | | | | Ш | | | | Ш | | | | | L | 1 | | _ | | <u> </u> | <u> </u> | |
| D-87 DIS | | L | | Щ | | | | Ш | | | | Ш | | ļ | | 1_ | | L | ļ | Ш | | ļ | ļ | <u> </u> | ļ | <u> </u> | L | \Box | 1.42 | _ | 0.20 | J+ |
| D-93 DIS | 28.6 | | 28.6 | U | 29.6 | | 29.6 | U | 0.95 | | | | | | | \perp | 1.18 | 0.15 | 0.065 | | 1.30 | 0.28 | 0.18 | | 1.02 | 0.3 | 0.20 | _ | 1.79 | 0.66 | 0.25 | ↓ |
| D-93 DIS (DUP) | _ | | | Ш | 46 | | 46 | U | | | L | Ш | | ļ | ļ | \perp | | L | | | | | | | 0.95 | 0.3 | 0.21 | | | <u> </u> | <u> </u> | <u> </u> |
| LR-100 DIS | | | | Ш | | | | Ц | | | | Ш | | | | \perp | | | | Ш | | | | | <u> </u> | 1 | | | 0.83 | _ | 0.28 | |
| LR-103 DIS | | | | Щ | | | | Ш | | | | Ш | | ļ | L | \perp | | | | \sqcup | | | ļ | _ | ļ | ļ | | _ | 1.10 | 0.51 | | \perp |
| LR-104 DIS | | | | Ш | | ļ | | Ц | | | | Ш | | ļ | | \perp | | | | Ш | | | | | | 1 | | \Box | 0.48 | 0.33 | 0.33 | + |
| LR-104 DIS (DUP) | | | | | | | | Ц | | | | | | | ļ | \perp | | | | \sqcup | | | ļ | <u> </u> | ļ | <u> </u> | \sqcup | \sqcup | 0.71 | 0.37 | 0.25 | J |
| LR-105 DIS | | Ĺ | L | | | | | | | | | | 1.58 | 0.23 | | \perp | | | | | | | | L | <u></u> | | 11 | | 1.14 | 0.47 | 0.20 | J+ |

Table 13: Summary of 2012 Radium-226 Results to Prior RI/FS Results

| | 1 1 | Nov 19 | 95 | | | Feb 19 | 196 | | | /lay 19 | 996 | _ | Fe | b - Mar | r 1997 | | Ma | v - Jur | ne 1997 | | 1 | Mar 20 | 004 | | N | /lay 2 | 004 | | | 201 | 2 | |
|---------------------------------|----------------|--|--|----------------|--|--------------|--|----------------|--------|----------|--------------|----------|--------------|--|--|----------|--------|--|--|----|--------------|----------------|--|--------------|-------------|--|------|----------|---------|------|------|--|
| Sample ID | _ | | | 10 | | | | 0 | Result | <u> </u> | | 0 | | | , | 0 | | - | | lo | Result | | _ | lo | | | | O | Result | | MDA | 6 |
| Sumple to | - Nesuit | 1 030 | IVIDA | ``` | Kesak | - 636 | IVIDA | H | resort | Ç30 | IVIDA | 15 | itesuit | C30 | IVIDA | - | resure | | INIOA | 13 | i itesuite | | , wier, | + | I | - | | Ť | 1100011 | | | |
| MW-102 DIS | | | | + | | | <u> </u> | Н | | | | | | | | 1 | | <u> </u> | | | 0.25 | | 0.25 | u | 0.20 | | 0.20 | u | 0.86 | 0.41 | 0.24 | |
| MW-102 DIS | + | | | + | | | | \vdash | | | | | 1.77 | 0.77 | 0.92 | \vdash | 0.502 | 0.33 | 0.415 | + | 0.25 | | 0.23 | +- | 3.20 | | 0.20 | ۲ | 0.27 | 0.21 | 0.21 | |
| MW-103 DIS (DUP) | + | | | + | | | | Н | | | | \vdash | 0.14 | 0.77 | 0.14 | П | 0.947 | 0.44 | | - | | | | + | | | | + | 0.27 | 0.22 | 0.21 | Ť |
| MW-104 DIS | | | | + | - | | | H | | | | | 0.14 | | 0.14 | Ť | 0.547 | 0.44 | 0.430 | + | | | - | | | | | \vdash | 0.46 | 0.29 | 0.19 | J |
| MW-1204 DIS | 1 | | | + | | - | | Н | | | | + | 3.03 | 1.03 | 1.1 | 1 | 2.19 | 0.68 | 0.56 | + | | | | $^{+}$ | | | | + | 2.79 | 0.88 | | ر |
| MW-1204 DIS (DUP) | + | | | + | | | | - | | | | + | 3.03 | 1.03 | | H | 2.38 | 0.73 | - | + | | | - | †- | | | | H | 2.73 | 0.00 | 0.27 | ۲ |
| PZ-100-KS DIS | + | <u> </u> | | + | | <u> </u> | | \vdash | | | | | | | | | 2.50 | 0.73 | 0.007 | + | 1 | | _ | †- | | <u> </u> | | + | 0.21 | 0.21 | 0.25 | U |
| PZ-100-K3 DIS | - | | | + | - | | | H | | _ | | + | 2.18 | 0.9 | 1.08 | H | 1.39 | 0.6 | 0.721 | + | | | | + | | | | | 2.69 | 0.87 | 0.28 | |
| PZ-100-SS DIS | - | | | + | | | | H | | | | + | 1.9 | 0.84 | + | T | 2.4 | 0.68 | | + | _ | | | + | | - | | + | 3.95 | 1.15 | 0.27 | \Box |
| PZ-101-SS DIS | + | | | + | | | 1 | H | | | · | - | 1.5 | 0.04 | 1.05 | \vdash | | 0.00 | 0.555 | + | | | | + | | | | | 28.87 | 6.55 | 0.24 | <u>г</u> |
| PZ-102R-SS DIS | + | ├ ┄─ | | +- | | | _ | H | | | | ╁╌ | 2.03 | 1.02 | 1.25 | \vdash | 1.05 | 0.44 | 0.42 | +- | t | | | +- | | | | + | 3.62 | 1.08 | 0.25 | \vdash |
| PZ-102-SS DIS | + | | | + | | | + | \vdash | | | | | 2.03 | 1.02 | 1.23 | H | 1.05 | 0.44 | 0.12 | + | | ļ | <u> </u> | ╁╴ | | | | + | 3.63 | 1.06 | 0.20 | П |
| PZ-103-SS DIS | + | | <u> </u> | + | | | | Н | | | | + | | | <u> </u> | | | | | + | | | | + | | | | † | 3.09 | 1.00 | 0.24 | H |
| PZ-103-53 DIS | | | | + | | | + | H | | | | 1 | | | | t | | | 1 | + | • | | | | | | | + | 0.28 | 0.23 | 0.24 | |
| PZ-104-K3 DIS | 1 | | | ╁ | | - | 1 | H | | | | +- | 2.39 | 0.91 | 0.971 | | 1.27 | 0.58 | 0.682 | ╁╌ | | | | ╁ | | <u> </u> | | + | 9.74 | 2.73 | 0.46 | ر |
| PZ-104-35 DIS | | | | + | | | 1 | Н | - | | | \vdash | 2.55 | 0.84 | + | \vdash | 1.15 | 0.58 | | +- | | 1 | | ╁ | | | | + | 1.60 | 0.58 | 0.21 | <u> </u> |
| PZ-104-33 DIS | + | | + | + | | | | \vdash | | | | \vdash | 2.33 | 0.04 | 0.001 | | 1.13 | 0.56 | 0.722 | + | | - | - | + | | | | ╁ | 1.92 | 0.65 | 0.28 | J+ |
| PZ-103-33 DIS PZ-106-KS DIS | | | | + | | | - | Н | | | | + | | | | 1 | | | | + | | | | + | | | | + | 0.27 | 0.22 | 0.24 | 7. |
| PZ-106-SD DIS | | | | + | | | | Н | | | | - | 1.84 | 0.85 | 1.07 | | 0.706 | | 0.706 | u | ļ | | | + | | | | + | 1.28 | 0.52 | 0.23 | ۲ |
| PZ-106-SS-DIS | | | | + | | - | | Н | | | | +- | 2.62 | 0.83 | 0.944 | | 2.53 | 0.73 | + | +- | | | | + | | | | + | 2.90 | 0.91 | 0.28 | М |
| PZ-106-33-DIS | | | | + | 0.069 | 0.03 | 0.043 | ├ ─ | | | | \vdash | 2.02 | 0.5 | 0.544 | ╁╾ | 2.33 | 0.73 | 0.013 | + | 1 | | | + | | | | + | 5.02 | 1.39 | 0.22 | |
| PZ-107-33 DIS | + | <u> </u> | | + | 0.003 | 0.03 | 0.043 | Н | | | l | + | | | | +- | | - | _ | + | 1 | | | + | | | | + | 2.35 | 0.80 | 0.35 | j |
| PZ-110-SS DIS | 1 | | | + | - | | 1 | | | | | +- | 4.9 | 1.25 | 1.17 | | 3.43 | 0.76 | 0.516 | + | | | | + | | <u> </u> | | +- | 5.01 | 1.36 | 0.19 | Ť |
| PZ-111-KS DIS | + | | | + | 1 | | ļ | - | | | | H | 7.5 | 1.23 | 1, | \vdash | 3.43 | 0.70 | 0.510 | + | | | <u> </u> | ╁ | | | | + | 0.32 | 0.25 | 0.22 | Ť |
| PZ-111-SD DIS | + | | | + | | | 1 | | | | | \vdash | 2.07 | 0.83 | 0.959 | \vdash | 1.34 | 0.61 | 0.745 | + | | - | | + | | | | + | 1.26 | 0.47 | 0.15 | J+ |
| PZ-111-35 DIS | | | | + | - | | - | H | - | | | Н | 2.07 | 0.00 | 0.555 | ╁ | 1.54 | 0.01 | 0.7.15 | + | ì | | | + | | | | + | 3.08 | 1.04 | 0.36 | |
| PZ-112-AS DIS | | | | + | | | | | | | | H | 1.09 | 0.73 | 1.05 | \vdash | 0.773 | 0.4 | 0.483 | + | | | | + | | 1 | | + | 0.73 | 0.42 | 0.39 | \Box |
| PZ-113-AS DIS | | | | + | | | | Н | | | | | 2.24 | 0.91 | + | | 0.68 | 0.4 | 0.483 | | - | | | + | | 1 | | + | 1.94 | 0.64 | 0.15 | Ť |
| PZ-113-33 DIS | | - | | + | | | | Н | | | <u> </u> | \vdash | 2.5 | 0.98 | 1.16 | | 1.39 | 0.6 | 0.732 | + | | | | + | | | | \vdash | 4.51 | 1.40 | 0.31 | Ť |
| PZ-113-AD DIS (DUP) | 1 | | | + | | | | H | | | | +- | 2.92 | 1.06 | + | | 1.33 | 0.0 | 0.732 | +- | | | | + | | 1 | | + | 1.21 | 0.56 | 0.24 | |
| PZ-113-AD DIS (DGF) | 24.6 | | 24.6 | + | 35.8 | | 35.8 | υ | 0.51 | | | +- | 2.32 | 1.00 | 1.10 | \vdash | | | | + | | | - | + | | | | + | 0.72 | 0.36 | 0.19 | ۲ |
| PZ-115-SS DIS | 24.0 | | 24.0 | + | 33.00 | | 33.8 | | 0.51 | | | | | | | ┼ | | | 1 | + | • | | | + | | | | + | 6.49 | 1.71 | 0.33 | \vdash |
| PZ-113-33 DIS PZ-116-SS DIS | | | | | | | + | Н | | | | | | | + | ╁╌ | | | | + | | | | + | | \vdash | | + | 0.19 | 0.24 | 0.39 | UJ |
| PZ-200-SS DIS | + | | | | | | - | Н | | - | | \vdash | | | | | | | | +- | | | | + | | | | | 3.12 | 0.97 | 0.28 | J |
| PZ-200-SS DIS (DUP) | | | | + | | | | H | | | | | | | - | + | | | | + | | | | + | | | | + | 4.50 | 1.28 | 0.17 |] |
| PZ-200-33 DIS (DUP) | + | | | + | | | | | | | | | 0.907 | | 0.907 | ╁ | 0.893 | 0.46 | 0.536 | + | | - | | ╁ | | | | + | 0.45 | 0.27 | 0.23 | J+ |
| PZ-201A-SS DIS (DUP) | + | | | | | | | H | | | | +- | 0.507 | | 0.507 | ۲ | 0.053 | 0.40 | 0.550 | + | - | | | + | | | | ╁╌ | 0.43 | 0.15 | 0.18 | UJ+ |
| PZ-201A-55 DIS (DUP) | - | | | + | | | - | Н | | | | | | - | | ⊢ | | | 1 | + | | | - | + | | | | \vdash | 0.13 | 0.13 | 0.18 | I I |
| PZ-202-33 DIS PZ-203-SS DIS | 1 | - | | + | | | | | | | ļ | | | | + | \vdash | | | | +- | | | - | + | | <u> </u> | | + | 1.08 | 0.45 | 0.23 | J+ |
| PZ-203-33 DIS PZ-204A-SS DIS | _ | | | + | | | | ╌┤ | | | | + | 1.11 | 0.65 | 0.88 | ┼- | 0.43 | | 0.43 | u | - | | | + | | | | + | 0.72 | 0.37 | 0.24 | 1 |
| PZ-204A-SS DIS | + | - | - | - | | | 1 | Н | | | | \vdash | 1.11 | 0.03 | U.08 | - | 0.43 | - | 0.43 | + | 1 | - | | + | | \vdash | | + | 1.41 | 0.62 | 0.24 | لئا |
| | +- | | | +- | | - | + | Н | | | | +- | | | - | +- | | + | 1 | + | | | - | ╁ | | | | + | 1.33 | 0.57 | 0.33 | J |
| PZ-205-AS DIS PZ-205-SS DIS | | - - | + | + | - | - | 1 | Н | | | | + | | | | | | | | + | 1 | - | + | +- | | - | | + | 1.54 | 0.57 | 0.24 | |
| | + | - | - | + | - | | ļ | Н | | | | \vdash | 1.0 | 0.0 | 1 12 | - | 1.19 | 0.57 | 0.669 | + | 1 - | 1 | | + | | | | + | 0.91 | 0.39 | 0.22 | لئا |
| PZ-206-SS DIS | + | | | | | | + | \vdash | | | | \vdash | 1.9 | 0.9 | 1.12 | - | 1.19 | 0.57 | 0.009 | + | | | | + | | - | | + | 0.73 | 0.40 | 0.26 | |
| PZ-207-AS DIS | + | - | - | + | | - | + | Н | | | | | 1 40 | 0.73 | 0.005 | | 1 1 5 | 0.45 | 0.412 | + | | ļ | - | + | | - | | + | 0.73 | 0.38 | 0.26 | |
| PZ-208-SS DIS | _l | L | _ | | L | | <u> </u> | | | | | | 1.48 | 0.72 | 0.905 | <u> </u> | 1.15 | 0.45 | 0.412 | | <u> </u> | | 1 | 1 | L | L | i | 1 | 0.52 | 0.27 | 0.14 | |

Table 13: Summary of 2012 Radium-226 Results to Prior RI/FS Results

| | | Nov 19 | | | | Feb 19 | | | | /lay 1 | | | | | 1997 | | | | e 1997 | | | /lar 20 | | | | 1ay 20 | | \Box | | 201 | | |
|---------------------------------|------------|-----------|----------|--------|------------|----------|-----------|-------|------------|--------|----------|------|----------|---------|----------|---|--------|------|--------|---|--------|---------|-----|---|--------|--------|-----|--------|--------|--------------|------|--------|
| Sample ID | Result | CSU | MDA | Q | Result | CSU | MDA | Q | Result | CSU | MDA | Q | Result | CSU | MDA | Q | Result | CSU | MDA | Q | Result | CSU | MDA | Q | Result | CSU | MDA | Q | Result | csu | MDA | Q |
| | | | | | | | | | | | | | Ī | | | | | | | | | | | T | | | | П | | | | |
| PZ-302-AI DIS | | | | | | | | | | | | Ī | Ī | | | | | | | | | | | | | | | П | 0.47 | 0.29 | 0.25 | j |
| PZ-303-AS DIS | | | | | | | | | | | | | 1.31 | 0.69 | 0.91 | | 1.15 | 0.48 | 0.502 | | | | | | | | | | 0.36 | 0.23 | 0.20 | J |
| PZ-304-AI DIS | | | | | | | | | | | | Γ | 1.31 | 0.83 | 1.15 | | 0.87 | 0.48 | 0.613 | | | | | Т | | | | | 1.93 | 0.76 | 0.35 | J |
| PZ-304-AI DIS (DUP) | | | | | | | | Π | | | | Т | 1.91 | 0.79 | 0.917 | | 1.38 | 0.55 | 0.566 | | | | | Т | | | | | | | | |
| PZ-304-AS DIS | | | | | | | | | | | | | 2.34 | 0.87 | 0.926 | | 0.896 | 0.62 | 0.888 | | | | | | | | | | 1.61 | 0.68 | 0.32 | |
| PZ-305-AI DIS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0.70 | 0.43 | 0.42 | J |
| | | | | | | | | | | | | | | | | | | | | | | | | Т | | | | | | | | \Box |
| Notes: | | | | | | | | | | | <u> </u> | | | | | | | | | | | | | | | | | | | | | |
| All values are in units of pico | Curies pe | r liter (| pCi/l) | | | | | | | | | | | | | | | | | | | | | | | | | Ш | | | L | |
| For the results prior to 2012, | only the | results | for we | ells s | sampled i | n 2012 | are rep | orte | d. | | | | | | l | | | | | | | | | | | | | Ш | | $oxed{oxed}$ | L | |
| DIS = dissolved sample (field | filtered s | ample) | ; TOT = | tot | tal sample | e (unfil | ered sa | mple | e) | | | | | | | | | L | | | | | | | | | Ĺ | Ш | | | | |
| DUP = Duplicate samples; Fie | ld duplica | ates w | ere coll | ecte | ed from t | he follo | wing lo | catio | ons: DUP | 01 = P | Z-201A- | SS, | DUP 02 = | PZ-200 |)-SS, | | | | | | | | | | | | | | | | | \Box |
| DUP 03 = PZ-113-Ad, DUP- | 04 = D-6, | DUP-0 | 5 = D-3 | , DL | JP 06 = D | -13, DL | P 07 = L | R-1(| 04, and DI | JP 08 | = I-9. | | | | | | | | | | | | | | | | Ĺ | | | | | |
| CSU = Combined Standard Ui | ncertainty | y (2-sig | ma); M | DA | = Minim | um Det | ectable . | Acti | vity | | | Τ | | | T | | | | | | | | | | | | | П | | | | |
| Data Validation Qualifiers (Fi | nal Q) inc | lude: l | J = Non | -de | tect at th | e repo | rted valu | ıe, | | | | | | | | | | | | | | | | | | | | | | | ı - | |
| UJ = Non-Detect at the | estimate | d repo | rted va | lue, | , UJ+ = No | on-Det | ect at th | e es | timated r | eport | ed value | e wh | nich may | be bias | ed high, | | | | | | | _ | | | | | | \Box | | | | |
| J = estimated result; J+ | = estima | ted res | ult whi | ich ı | may be b | iased h | igh | | | | | | | | | | | | | | | | | | | | | | | | | |

Table 14: Summary of Detected Trace Metal Results

| | Sample | Sample | Alumi- | Anti- | | <u> </u> | Chro- | | | | Manga- | Mer- | | Vana- | |
|-----------|-----------|-----------|----------|-------|---------|----------|-------|--------|-------|-------|--------|---------|--------|-------|--------|
| Sample ID | Date | Fraction | num | mony | Arsenic | Barium | mium | Cobalt | Iron | Lead | nese | cury | Nickel | dium | Zinc |
| S-5 | 8/14/2012 | Dissolved | 1000 U | 50 U | 50 U | 420 | 50 U | 250 U | 11000 | 50 U | 110 | 0.2 U | 200 U | 250 U | 100 U |
| S-5 | 8/14/2012 | Total | 1000 U | 50 U | 14 J | 420 | 16 J | 250 U | 13000 | 18 J | 130 | 0.2 U | 93 J | 250 U | 100 |
| S-8 | 8/9/2012 | Dissolved | 1000 U | 50 U | 15 U | 260 | 50 U | 250 U | 920 | 50 U | 880 | 0.2 U | 200 U | 250 U | 100 U |
| S-8 | 8/9/2012 | Total | 1000 U | 24 U | 15 U | 300 | 50 U | 250 U | 3000 | 50 U | 1000 | 0.2 UJ- | 200 U | 250 U | 35 U |
| S-10 | 8/8/2012 | Dissolved | 590 J | 50 U | 36 U | 100 J | 50 U | 250 U | 61000 | 50 U | 2800 | 0.2 UJ- | 200 U | 250 U | 100 U |
| S-10 | 8/8/2012 | Total | 790 J+ | 10 U | 36 | 110 | 10 U | 50 U | 65000 | 1.8 J | 3100 | 0.2 UJ- | 18 J | 11 J | 20 U |
| S-61 | 8/7/2012 | Dissolved | 1000 U | 50 U | 50 U | 190 J | 50 U | 250 U | 500 U | 9.0 J | 580 | 0.20 U | 200 U | 250 U | 100 U |
| S-61 | 8/7/2012 | Total | 1300 | 10 U | 10 U | 250 | 10 U | 6.6 J | 6400 | 27 | 720 | 0.20 U | 21 J | 6.6 J | 33 J+ |
| S-82 | 8/10/2012 | Dissolved | 1000 U | 50 U | 200 | 900 | 50 U | 250 U | 32000 | 50 U | 1800 | 0.2 U | 200 U | 250 U | 28 U |
| S-82 | 8/10/2012 | Total | 3200 | 50 U | 230 | 1300 | 50 U | 250 U | 45000 | 51 | 2000 | 0.2 UJ- | 200 U | 250 U | 150 J+ |
| S-84 | 8/6/2012 | Dissolved | 1000 U | 50 U | 110 | 840 | 50 U | 28 J | 48000 | 50 U | 1900 | 0.2 UJ- | 200 U | 250 U | 100 U |
| S-84 | 8/6/2012 | Total | 11000 J+ | 10 U | 120 | 1100 | 16 | 69 | 69000 | 25 | 2300 | 0.086 U | 93 | 32 J | 150 |
| 1-4 | 8/14/2012 | Dissolved | 1000 U | 50 U | 50 U | 1200 | 50 U | 250 U | 31000 | 8.0 J | 880 | 0.2 U | 200 U | 250 U | 100 U |
| 1-4 | 8/14/2012 | Total | 1000 U | 50 U | 50 U | 1400 | 50 U | 250 U | 41000 | 50 U | 980 | 0.2 U | 200 U | 250 U | 100 U |
| 1-9 | 8/14/2012 | Dissolved | 1000 U | 50 U | 50 U | 1100 | 50 U | 250 U | 18000 | 50 U | 360 | 0.2 U | 200 U | 250 U | 100 U |
| 1-9 | 8/14/2012 | Total | 1000 U | 50 U | 50 U | 1100 | 50 U | 250 U | 20000 | 9.5 J | 390 | 0.2 U | 200 U | 250 U | 100 U |
| I-9 DUP | 8/14/2012 | Dissolved | 1000 U | 50 U | 50 U | 1100 | 50 U | 250 U | 19000 | 50 U | 370 | 0.2 U | 200 U | 250 U | 100 U |
| I-9 DUP | 8/14/2012 | Total | 1000 U | 50 U | 50 U | 1200 | 50 U | 250 U | 21000 | 50 U | 410 | 0.2 U | 200 U | 250 U | 100 U |
| I-11 | 8/8/2012 | Dissolved | 1000 U | 50 U | 15 U | 760 | 50 U | 250 U | 22000 | 50 U | 1200 | 0.2 UJ- | 200 U | 250 U | 100 U |
| I-11 | 8/8/2012 | Total | 200 U | 10 U | 15 | 860 | 10 U | 50 U | 25000 | 10 U | 1300 | 0.2 UJ- | 13 J | 6.8 J | 6.1 U |
| 1-62 | 8/9/2012 | Dissolved | 1000 U | 50 U | 50 U | 270 | 50 U | 250 U | 3800 | 50 U | 400 | 0.2 U | 200 U | 250 U | 100 U |
| I-62 | 8/9/2012 | Total | 2500 | 50 U | 30 U | 380 | 50 U | 250 U | 13000 | 12 J | 620 | 0.2 UJ- | 200 U | 250 U | 81 U |
| 1-65 | 8/6/2012 | Dissolved | 1000 U | 50 U | 50 U | 200 J | 50 U | 250 U | 500 U | 50 U | 83 | 0.2 UJ- | 200 U | 250 U | 100 U |
| I-65 | 8/6/2012 | Total | 1300 J+ | 10 U | 10 U | 250 | 10 U | 7.9 J | 2100 | 4.9 J | 640 | 0.069 U | 20 J | 6.0 J | 19 J+ |
| I-66 | 8/10/2012 | Dissolved | 1000 U | 50 U | 50 U | 100 J | 50 U | 250 U | 1900 | 50 U | 3200 | 0.2 U | 200 U | 250 U | 100 U |
| I-66 | 8/10/2012 | Total | 1000 U | 50 U | 50 U | 120 J | 50 U | 250 U | 4000 | 9.5 J | 3600 | 0.2 UJ- | 200 U | 250 U | 100 U |
| 1-67 | 8/10/2012 | Dissolved | 1000 U | 50 U | 50 U | 210 J | 50 U | 250 U | 5900 | 50 U | 1100 | 0.2 U | 200 U | 250 U | 100 U |
| 1-67 | 8/10/2012 | Total | 1000 U | 50 U | 50 U | 230 J | 50 U | 250 U | 7300 | 50 U | 1200 | 0.2 UJ- | 200 U | 250 U | 100 U |
| 1-68 | 8/6/2012 | Dissolved | 1000 U | 50 U | 11 U | 540 | 50 U | 250 U | 400 J | 50 U | 1400 | 0.2 UJ- | 200 U | 250 U | 100 U |
| 1-68 | 8/6/2012 | Total | 35000 J+ | 5.4 J | 11 | 730 | 64 | 26 J | 31000 | 100 | 1600 | 0.38 | 91 | 75 | 420 |
| I-73 | 8/4/2012 | Dissolved | 200 U | 10 U | 45 | 680 | 10 U | 7.6 J | 32000 | 4.7 J | 1100 | 0.080 U | 49 | 50 U | 570 |
| 1-73 | 8/4/2012 | Total | 12000 | 10 U | 58 | 820 | 18 | 11 J | 61000 | 110 | 1500 | 0.20 U | 73 | 24 J | 6300 |
| D-3 | 8/8/2012 | Dissolved | 1000 U | 50 U | 13 U | 1800 | 50 U | 250 U | 27000 | 50 U | 410 | 0.2 UJ- | 200 U | 250 U | 100 U |

Table 14: Summary of Detected Trace Metal Results

| | Sample | Sample | Alumi- | Anti- | | | Chro- | | | | Manga- | Mer- | | Vana- | |
|------------|-----------|-----------|----------|-------|---------|--------|-------|--------|--------|-------|--------|----------|--------|-------|-------|
| Sample ID | Date | Fraction | num | mony | Arsenic | Barium | mium | Cobalt | Iron | Lead | nese | cury | Nickel | dium | Zinc |
| D-3 | 8/8/2012 | Total | 200 U | 10 U | 10 U | 2100 | 10 U | 4.9 J | 31000 | 1.7 J | 470 | 0.2 UJ- | 18 J | 50 U | 5.5 U |
| D-3 DUP | 8/8/2012 | Dissolved | 1000 U | 50 U | 50 U | 2000 | 50 U | 250 U | 31000 | 50 U | 460 | 0.2 UJ- | 200 U | 250 U | 100 U |
| D-3 DUP | 8/8/2012 | Total | 200 U | 4.5 J | 10 U | 2100 | 10 U | 4.6 J | 31000 | 10 U | 470 | 0.2 UJ- | 17 J | 5.1 J | 5.8 U |
| D-6 | 8/7/2012 | Dissolved | 1000 U | 50 U | 50 U | 950 | 50 U | 250 U | 14000 | 50 U | 420 | 0.20 U | 200 U | 250 U | 100 U |
| D-6 | 8/7/2012 | Total | 200 U | 10 U | 10 U | 1100 | 10 U | 50 U | 15000 | 3.0 J | 490 | 0.20 U | 40 U | 4.4 J | 20 J+ |
| D-6 DUP | 8/7/2012 | Dissolved | 1000 U | 50 U | 50 U | 1100 | 50 U | 250 U | 16000 | 50 U | 500 | 0.20 U | 200 U | 22 J | 100 U |
| D-6 DUP | 8/7/2012 | Total | 200 U | 10 U | 10 U | 1100 | 10 U | 50 U | 15000 | 2.3 J | 480 | 0.20 U | 40 U | 50 U | 11 U |
| D-12 | 8/8/2012 | Dissolved | 1000 U | 50 U | 50 U | 470 | 50 U | 250 U | 11000 | 11 J | 1100 | 0.2 UJ- | 200 U | 250 U | 100 U |
| D-12 | 8/8/2012 | Total | 230 J+ | 10 U | 10 U | 490 | 10 U | 50 U | 15000 | 2.3 J | 1100 | 0.2 UJ- | 40 U | 50 U | 10 U |
| D-13 | 8/10/2012 | Dissolved | 1000 U | 50 U | 50 U | 530 | 50 U | 250 U | 11000 | 50 U | 310 | 0.2 U | 200 U | 250 U | 100 U |
| D-13 | 8/10/2012 | Total | 550 J | 50 U | 50 U | 550 | 50 U | 250 U | 16000 | 50 U | 340 | 0.2 UJ- | 200 U | 250 U | 100 U |
| D-13 DUP | 8/10/2012 | Dissolved | 1000 U | 50 U | 50 U | 510 | 50 U | 250 U | 11000 | 50 U | 310 | 0.2 U | 200 U | 250 U | 100 U |
| D-13 DUP | 8/10/2012 | Total | 940 J | 50 U | 50 U | 600 | 50 U | 250 U | 21000 | 50 U | 390 | 0.2 UJ- | 200 U | 250 U | 26 U |
| D-81 | 8/9/2012 | Dissolved | 1000 U | 50 U | 50 U | 390 | 50 U | 250 U | 18000 | 50 U | 1100 | 0.2 U | 200 U | 250 U | 100 U |
| D-81 | 8/9/2012 | Total | 1000 U | 50 U | 10 U | 400 | 50 U | 250 U | 18000 | 9.0 J | 1100 | 0.2 UJ- | 200 U | 250 U | 65 U |
| D-83 | 8/9/2012 | Dissolved | 1000 U | 50 U | 50 U | 1100 | 50 U | 250 U | 11000 | 50 U | 260 | 0.2 U | 200 U | 250 U | 100 U |
| D-83 | 8/9/2012 | Total | 1000 U | 50 U | 50 U | 960 | 50 U | 250 U | 9400 | 50 U | 240 | 0.2 UJ- | 200 U | 250 U | 27 J |
| D-85 | 8/6/2012 | Dissolved | 1000 U | 50 U | 32 U | 1800 | 50 U | 250 U | 50000 | 50 U | 950 | 0.2 UJ- | 200 U | 250 U | 100 U |
| D-85 | 8/6/2012 | Total | 51000 J+ | 10 U | 82 | 6100 | 100 | 88 | 340000 | 170 | 9200 | 0.22 U | 230 | 130 | 720 |
| D-87 | 8/1/2012 | Dissolved | 200 U | 10 U | 10 U | 1200 | 10 U | 50 U | 30000 | 10 U | 530 | 0.20 UJ- | 18 J | 50 U | 6.9 U |
| D-87 | 8/1/2012 | Total | 140 J | 4.6 J | 10 U | 1100 | 10 U | 50 U | 29000 | 4.7 J | 520 | 0.20 UJ- | 40 U | 4.3 J | 20 U |
| D-93 | 8/14/2012 | Dissolved | 1000 U | 50 U | 50 U | 1400 | 50 U | 250 U | 32000 | 50 U | 900 | 0.2 U | 200 U | 250 U | 100 U |
| D-93 | 8/14/2012 | Total | 730 J | 50 U | 50 U | 1400 | 50 U | 250 U | 39000 | 12 J | 900 | 0.2 U | 200 U | 250 U | 100 U |
| LR-100 | 8/13/2012 | Dissolved | 1000 U | 50 U | 50 U | 450 | 50 U | 250 U | 21000 | 50 U | 190 | 0.2 U | 200 U | 250 U | 100 U |
| LR-100 | 8/13/2012 | Total | 1800 | 50 U | 50 U | 440 | 50 U | 250 U | 23000 | 95 | 220 | 0.13 J | 200 U | 250 U | 260 |
| LR-103 | 8/13/2012 | Dissolved | 1000 U | 50 U | 64 | | 50 U | 250 U | 37000 | 50 U | 1000 | 0.2 U | 200 U | 250 U | 100 U |
| LR-103 | 8/13/2012 | Total | 1900 | 50 U | 78 | 1000 | 50 U | 250 U | 39000 | 50 U | 1100 | 0.2 U | 200 U | 250 U | 42 J |
| LR-104 | 8/13/2012 | Dissolved | 1000 U | 50 U | 50 U | 450 | 50 U | 250 U | 17000 | 8.0 J | 1200 | 0.2 U | 200 U | 250 U | 34 U |
| LR-104 | 8/13/2012 | Total | 1000 U | 50 U | 50 U | 450 | 50 U | 250 U | 17000 | 7.5 J | 1200 | 0.2 U | 200 U | 250 U | 28 J |
| LR-104 DUP | 8/13/2012 | Dissolved | 1000 U | 50 U | | | 50 U | 250 U | 16000 | 7.5 J | 1200 | 0.2 U | 200 U | 250 U | 100 U |
| LR-104 DUP | 8/13/2012 | Total | 1000 U | 50 U | 50 U | 430 | 50 U | 250 U | 16000 | 50 U | 1200 | 0.2 U | 200 U | 250 U | 100 U |
| LR-105 | 8/1/2012 | Dissolved | 200 U | 10 U | | | 4.3 J | 9.6 J | 15000 | 1.5 J | 52 | 0.20 UJ- | 100 | 50 U | 8.1 U |
| LR-105 | 8/1/2012 | Total | 610 | 4.5 J | 4.8 J | 720 | 10 | 8.7 J | 15000 | 15 | 70 | 0.065 J- | 92 | 4.1 U | 59 |

Table 14: Summary of Detected Trace Metal Results

| | Sample | Sample | Alumi- | Anti- | 1 | | Chro- | | | · | Manga- | Mer- | | Vana- | |
|------------|-----------|-----------|--------|-------|---------|--------|-------|--------|--------|-------|--------|----------|--------|-------|--------|
| Sample ID | Date | Fraction | num | mony | Arsenic | Barium | mium | Cobalt | Iron | Lead | nese | cury | Nickel | dium | Zinc |
| MW-102 | 8/7/2012 | Dissolved | 1000 U | 50 U | 21 U | 390 | 50 U | 250 U | 5700 | 50 U | 1600 | 0.20 U | 200 U | 250 U | 100 U |
| MW-102 | 8/7/2012 | Total | 450 | 10 U | 10 | 490 | 10 U | 4.7 J | 10000 | 6.4 J | 2000 | 0.20 U | 18 J | 5.3 J | 23 J+ |
| MW-103 | 8/11/2012 | Dissolved | 1000 U | 50 U | 50 U | 230 J | 50 U | 250 U | 500 U | 50 U | 730 | 0.2 U | 200 U | 250 U | 100 U |
| MW-103 | 8/11/2012 | Total | 80000 | 50 U | 30 J | 1100 | 100 | 52 J | 98000 | 130 | 2700 | 0.26 J- | 160 J | 200 J | 630 |
| MW-104 | 8/9/2012 | Dissolved | 1000 U | 50 U | 68 J+ | 550 | 50 U | 250 U | 50000 | 50 U | 4400 | 0.2 U | 200 U | 250 U | 100 U |
| MW-104 | 8/9/2012 | Total | 15000 | 50 U | 75 J+ | 850 | 20 J | 250 U | 63000 | 39 J | 4500 | 0.2 UJ- | 200 U | 39 J | 180 J+ |
| MW-1204 | 8/2/2012 | Dissolved | 200 U | 10 U | 10 U | 290 | 10 U | 50 U | 5100 | 10 U | 100 | 0.061 J | 40 U | 50 U | 9.8 U |
| MW-1204 | 8/2/2012 | Total | 170 J+ | 10 U | 10 U | 290 | 10 U | 50 U | 5700 J | 2.7 J | 120 J+ | 0.20 U | 40 U | 50 U | 34 J+ |
| PZ-100-KS | 8/16/2012 | Dissolved | 1000 U | 50 U | 50 U | 250 U | 50 U | 250 U | 500 U | 50 บ | 18 J | 0.2 U | 200 U | 250 U | 44 J |
| PZ-100-K\$ | 8/16/2012 | Total | 1000 U | 50 U | 50 U | 250 U | 50 U | 250 U | 200 J | 50 U | 21 J | 0.2 U | 200 U | 32 U | 37 J |
| PZ-100-SD | 7/31/2012 | Dissolved | 200 U | 10 U | 2.4 U | 310 | 10 U | 50 U | 1400 | 2.4 J | 73 | 0.20 U | 40 U | 50 U | 11 J |
| PZ-100-SD | 7/31/2012 | Total | 200 U | 10 U | 2.9 U | 320 | 10 U | 50 U | 1500 | 2.4 J | 74 | 0.20 U | 40 U | 50 U | 7.6 U |
| PZ-100-SS | 7/31/2012 | Dissolved | 200 U | 10 U | 10 U | 65 | 10 U | 50 U | 100 U | 10 U | 15 U | 0.083 J | 18 J | 50 U | 18 J |
| PZ-100-SS | 7/31/2012 | Total | 87 J | 4.2 J | 10 U | 69 | 10 U | 50 U | 54 U | 2.5 J | 4.7 J | 0.20 U | 17 J | 50 U | 13 U |
| PZ-101-S\$ | 8/7/2012 | Dissolved | 1000 U | 50 U | 20 U | 370 | 50 U | 250 U | 890 | 50 U | 62 J | 0.20 U | 200 U | 250 U | 100 U |
| PZ-101-SS | 8/7/2012 | Total | 200 U | 10 U | 6.5 J | 500 | 10 U | 50 U | 1500 | 2.2 J | 81 | 0.20 U | 18 J | 4.1 J | 26 J+ |
| PZ-102R-SS | 8/13/2012 | Dissolved | 1000 U | 50 U | 50 U | 86 J | 50 U | 250 U | 1100 | 50 U | 35 J | 0.2 U | 200 U | 250 U | 28 U |
| PZ-102R-SS | 8/13/2012 | Total | 1000 U | 50 U | 50 U | 88 J | 50 U | 250 U | 2100 | 10 J | 37 J | 0.2 U | 200 U | 250 U | 48 J |
| PZ-102-SS | 8/13/2012 | Dissolved | 1000 U | 50 U | 50 U | 500 | 50 U | 250 U | 2900 | 8.5 J | 290 | 0.2 U | 200 U | 250 U | 27 U |
| PZ-102-SS | 8/13/2012 | Total | 2200 | 50 U | 50 U | 570 | 50 U | 250 U | 8700 | 8.5 J | 360 | 0.2 U | 200 U | 250 U | 45 J |
| PZ-103-SS | 8/7/2012 | Dissolved | 1000 U | 50 U | 50 U | 660 | 50 U | 250 U | 18000 | 50 U | 120 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-103-SS | 8/7/2012 | Total | 17000 | 6.4 J | 25 | 1100 | 37 | 12 J | 42000 | 22 | 250 | 0.16 J | 55 | 52 | 290 |
| PZ-104-KS | 8/15/2012 | Dissolved | 1000 U | 50 U | 50 U | 57 J | 50 U | 250 U | 560 | 50 U | 75 U | 0.2 U | 200 U | 250 U | 63 J |
| PZ-104-KS | 8/15/2012 | Total | 530 J | 50 U | 50 U | 58 J | 50 U | 250 U | 1100 | 50 U | 21 J | 0.2 U | 200 U | 25 U | 28 J |
| PZ-104-SD | 8/1/2012 | Dissolved | 200 U | 5.0 J | 12 J+ | 1200 | 17 | 8.4 J | 28000 | 1.7 J | 190 | 0.20 UJ- | 52 | 16 J | 18 U |
| PZ-104-SD | 8/1/2012 | Total | 200 U | 4.8 J | 7.2 J | 520 | 5.1 J | 50 U | 13000 | 2.8 J | 140 | 0.20 UJ- | 18 J | 7.8 J | 15 J |
| PZ-104-SS | 8/1/2012 | Dissolved | 200 U | 10 U | 10 U | 100 | 10 U | 50 U | 2400 | 10 U | 65 | 0.20 UJ- | 40 U | 50 U | 14 U |
| PZ-104-SS | 8/1/2012 | Total | 200 U | 4.7 J | 2.5 J | 98 | 10 U | 50 U | 2300 | 2.1 J | 61 | 0.20 UJ- | 40 U | 50 U | 11 J |
| PZ-105-SS | 8/1/2012 | Dissolved | 200 U | 4.3 J | 10 U | 170 | 10 U | 50 U | 140 | 10 U | 6.1 U | 0.20 UJ- | 40 U | 50 U | 26 J+ |
| PZ-105-SS | 8/1/2012 | Total | 200 U | 10 U | 10 U | 170 | 10 U | 50 U | 540 | 2.9 J | 14 J | 0.20 UJ- | 40 U | 50 U | 22 |
| PZ-106-KS | 8/14/2012 | Dissolved | 1000 U | 50 U | 50 U | 45 J | 50 U | 250 U | 330 J | 50 U | 75 U | 0.2 U | 200 U | 250 U | 100 U |
| PZ-106-KS | 8/14/2012 | Total | 1000 U | 50 U | 50 U | 46 J | 50 U | 250 U | 590 | 50 U | 75 U | 0.2 U | 200 U | 250 U | 37 J |
| PZ-106-SD | 7/31/2012 | Dissolved | 200 U | 4.2 J | 10 U | 93 | 10 U | 50 U | 620 | 1.9 J | 69 | 0.20 U | 40 U | 50 U | 8.7 J |

Table 14: Summary of Detected Trace Metal Results

| | Sample | Sample | Alumi- | Anti- | | | Chro- | | | | Manga- | Mer- | | Vana- | |
|---------------|-----------|-----------|---------|-------|---------|--------|-------|--------|---------|-------|---------|----------|--------|-------|-------|
| Sample ID | Date | Fraction | num | mony | Arsenic | Barium | mium | Cobalt | Iron | Lead | nese | cury | Nickel | dium | Zinc |
| PZ-106-SD | 7/31/2012 | Total | 2700 | 10 U | 3.4 U | 130 | 5.7 J | 50 U | 4300 | 6.1 J | 160 | 0.20 U | 40 U | 6.6 U | 24 |
| PZ-106-SS | 7/31/2012 | Dissolved | 200 U | 10 U | 10 U | 140 | 10 U | 50 U | 510 | 2.1 J | 14 U | 0.20 U | 40 U | 50 U | 11 J |
| PZ-106-SS | 7/31/2012 | Total | 200 U | 5.4 J | 10 U | 140 | 10 U | 50 U | 460 | 1.6 J | 33 | 0.20 U | 40 U | 50 U | 20 U |
| PZ-107-SS | 8/3/2012 | Dissolved | 200 U | 10 U | 3.6 U | 590 | 10 U | 50 U | 2400 | 4.1 J | 120 | 0.067 U | 40 | 4.2 J | 11 J |
| PZ-107-SS | 8/3/2012 | Total | 200 U | 10 U | 4.9 U | 620 | 10 U | 50 U | 5900 | 1.6 J | 100 | 0.077 U | 44 | 50 U | 10 U |
| PZ-109-SS | 8/2/2012 | Dissolved | 200 U | 10 U | 10 U | 63 | 10 U | 50 U | 100 U | 10 U | 15 U | 0.075 J | 40 U | 50 U | 24 J+ |
| PZ-109-SS | 8/2/2012 | Total | 200 U | 10 U | 10 U | 58 | 10 U | 50 U | 43 J | 10 U | 15 U | 0.099 J | 40 U | 50 U | 21 J+ |
| PZ-110-SS | 8/2/2012 | Dissolved | 200 U | 10 U | 10 U | 330 | 10 U | 50 U | 6500 | 3.3 J | 210 | 0.074 J | 23 J | 50 U | 12 U |
| PZ-110-SS | 8/2/2012 | Total | 200 U | 4.1 J | 10 U | 320 | 10 U | 50 U | 7100 J | 2.6 J | 200 J+ | 0.088 J | 19 J | 50 U | 10 U |
| PZ-111-KS | 8/13/2012 | Dissolved | 1000 U | 50 U | 50 U | 250 U | 50 U | 250 U | 140 J | 50 U | 75 U | 0.2 U | 200 U | 250 U | 100 U |
| PZ-111-KS | 8/13/2012 | Total | 1000 U | 50 U | 50 U | 250 U | 50 U | 250 U | 200 J | 50 U | 75 U | 0.2 U | 200 U | 250 U | 100 U |
| PZ-111-SD | 8/1/2012 | Dissolved | 200 U | 5.5 J | 10 U | 120 | 10 U | 50 U | 100 U | 10 U | 15 U | 0.20 UJ- | 40 U | 50 U | 13 U |
| PZ-111-SD | 8/1/2012 | Total | 200 U | 10 U | 10 U | 110 | 10 U | 50 U | 230 | 10 U | 15 U | 0.20 UJ- | 40 U | 50 U | 8.6 J |
| PZ-112-AS | 8/8/2012 | Dissolved | 1000 U | 50 U | . 170 | 1800 | 50 U | 250 U | 37000 | 50 U | 220 | 0.2 UJ- | 200 U | 250 U | 100 U |
| PZ-112-AS | 8/8/2012 | Total | 300 J+ | 10 U | 190 | 2200 | 3.2 J | 50 U | 44000 | 4.4 J | 280 | 0.2 UJ- | 16 J | 7.5 J | 14 J |
| PZ-113-AD | 8/3/2012 | Dissolved | 200 U | 10 U | 10 U | 2000 J | 10 U | 5.1 J | 30000 | 3.4 J | 570 | 0.076 U | 16 J | 50 U | 7.2 J |
| PZ-113-AD | 8/3/2012 | Total | 200 U | 10 U | 10 U | 2000 J | 10 U | 4.7 J | 31000 | 1.9 J | 630 | 0.093 U | 17 J | 50 U | 5.6 U |
| PZ-113-AD DUP | 8/3/2012 | Dissolved | 200 U | 6.0 J | 13 J+ | 1300 J | 10 U | 50 U | 30000 | 4.6 J | 560 | 0.061 U | 17 J | 50 U | 8.4 J |
| PZ-113-AD DUP | 8/3/2012 | Total | 970 | 4.0 J | 18 | 1300 J | 10 U | 50 U | 33000 | 2.7 J | 610 | 0.078 U | 24 J | 4.7 J | 17 U |
| PZ-113-AS | 8/8/2012 | Dissolved | 1000 U | 50 U | 50 U | 740 | 50 U | 250 U | 6700 | 50 U | 6400 | 0.2 UJ- | 200 U | 250 U | 33 U |
| PZ-113-AS | 8/8/2012 | Total | 200 U | 4.9 J | 12 | 740 | 10 U | 11 J | 7500 | 2.3 J | 6400 | 0.2 UJ- | 29 J | 50 U | 9.9 U |
| PZ-113-SS | 8/4/2012 | Dissolved | 200 U | 10 U | 10 U | 170 | 10 U | 50 U | 92 | 2.5 J | 32 | 0.081 U | 40 U | 50 U | 13 J |
| PZ-113-SS | 8/4/2012 | Total | 5300 | 10 U | 4.8 U | 200 | 13 | 50 U | 4500 | 2.7 J | | 0.074 U | 14 J | 12 J | 41 J+ |
| PZ-114-AS | 7/31/2012 | Dissolved | 200 U | 10 U | 220 | 710 | 10 U | 7.3 J | 80000 | 3.2 J | 4100 | 0.20 U | 40 U | 6.2 J | 7.1 J |
| PZ-114-AS | 7/31/2012 | Total | 200 U | 5.4 J | 220 | 720 | 10 U | 5.8 J | 81000 | 3.2 J | 4200 | 0.20 U | 40 U | 7.0 J | 20 U |
| PZ-115-SS | 7/31/2012 | Dissolved | 200 U | 10 U | 2.9 U | 200 | 10 U | 5.6 J | 1500 | 3.6 J | 45 | 0.20 U | 24 J | 50 U | 12 J |
| PZ-115-SS | 7/31/2012 | Total | 200 U | 5.8 J | 3.4 U | 210 | 10 U | 4.0 J | 1900 | 2.9 J | 55 | 0.20 U | 24 J | 50 U | 5.7 U |
| PZ-116-SS | 8/3/2012 | Dissolved | 200 U | 10 U | 10 U | 59 | 10 U | 50 U | 100 U | 3.3 J | 15 U | 0.066 U | 40 U | 4.1 J | 28 |
| PZ-116-SS | 8/3/2012 | Total | 200 U | 10 U | 10 U | 63 | 10 U | 50 U | 69 J | 10 U | 16 | 0.20 U | 40 U | 4.4 J | 31 J+ |
| PZ-200-SS | 8/2/2012 | Dissolved | 200 U | 10 U | 10 U | 740 | 10 U | 50 U | 7800 | 2.3 J | 3200 | 0.077 J | 40 U | 5.1 J | 8.3 U |
| PZ-200-SS | 8/2/2012 | Total | 1400 J+ | 10 U | 12 J+ | 660 | 5.4 U | 50 U | 17000 J | 5.8 J | 2900 J+ | 0.16 J | 40 U | 11 J | 48 J+ |
| PZ-200-SS DUP | 8/2/2012 | Dissolved | 200 U | 10 U | 10 U | 690 | 10 U | 50 U | 7400 | 1.8 J | 2600 | 0.20 U | 40 U | 50 U | 8.6 U |
| PZ-200-SS DUP | 8/2/2012 | Total | 490 J+ | 5.2 J | 3.5 U | 630 | 10 U | 50 U | 9200 J | 4.8 J | 2600 J+ | 0.10 J | 40 U | 5.4 J | 20 J+ |

Table 14: Summary of Detected Trace Metal Results

| | Sample | Sample | Alumi- | Anti- | | | Chro- | | | | Manga- | Mer- |] | Vana- | |
|----------------|-----------|-----------|----------|-------|--|--------|-------|--------|---------|-------|---------|----------|--------|-------|-------|
| Sample ID | Date | Fraction | num | mony | Arsenic | Barium | mium | Cobalt | Iron | Lead | nese | cury | Nickel | dium | Zinc |
| PZ-201A-SS | 8/1/2012 | Dissolved | 200 U | 6.0 J | 10 U | 120 | 10 U | 50 U | 220 | 1.7 J | 38 | 0.20 UJ- | 40 U | 50 U | 59 J+ |
| PZ-201A-SS | 8/1/2012 | Total | 200 U | 10 U | 10 U | 120 | 10 U | 50 U | 190 | 3.6 J | 41 | 0.20 UJ- | 40 U | 50 U | 34 |
| PZ-201A-SS DUP | 8/1/2012 | Dissolved | 200 U | 10 U | 10 U | 120 | 10 U | 50 U | 170 | 1.6 J | 38 | 0.20 UJ- | 40 U | 50 Ü | 57 J+ |
| PZ-201A-SS DUP | 8/1/2012 | Total | 200 U | 5.0 J | 10 U | 120 | 10 U | 50 U | 180 | 3.4 J | 42 | 0.20 UJ- | 40 U | 50 U | 20 |
| PZ-202-SS | 8/2/2012 | Dissolved | 200 U | 10 U | 10 U | 410 | 10 U | 50 U | 1700 | 2.4 J | 590 | 0.20 U | 40 U | 50 U | 11 U |
| PZ-202-SS | 8/2/2012 | Total | 21000 J+ | 11 | 17 | 660 | 51 | 23 J | 21000 J | 46 | 1200 J+ | 0.18 J | 110 | 52 | 1600 |
| PZ-203-SS | 8/1/2012 | Dissolved | 200 U | 10 U | 10 U | 90 | 10 U | 50 U | 130 | 10 U | 20 J+ | 0.20 UJ- | 40 U | 50 U | 12 U |
| PZ-203-SS | 8/1/2012 | Total | 440 | 10 U | 10 U | 89 | 10 U | 50 U | 320 | 2.0 J | 21 | 0.20 UJ- | 40 U | 50 U | 10 J |
| PZ-204A-SS | 8/2/2012 | Dissolved | 200 U | 10 U | 15 J+ | 140 | 10 U | 50 U | 2500 | 1.5 J | 1000 | 0.063 J | 40 U | 50 U | 9.4 U |
| PZ-204A-SS | 8/2/2012 | Total | 160 J+ | 10 U | 21 | 340 | 10 U | 50 U | 5500 J | 3.5 J | 1000 J+ | 0.089 J | 40 U | 5.9 J | 33 J+ |
| PZ-204-SS | 8/3/2012 | Dissolved | 200 U | 10 U | 10 U | 180 | 10 U | 50 U | 550 | 3.1 J | 90 | 0.20 U | 40 U | 4.8 J | 8.1 J |
| PZ-204-SS | 8/3/2012 | Total | 370 | 10 U | 10 U | 200 | 10 U | 50 U | 2000 | 1.7 J | 100 | 0.11 U | 40 U | 6.4 J | 20 |
| PZ-205-AS | 8/3/2012 | Dissolved | 200 U | 4.2 J | 14 J+ | 1300 | 10 U | 50 U | 30000 | 5.4 J | 580 | 0.081 U | 17 J | 50 U | 20 U |
| PZ-205-AS | 8/3/2012 | Total | 940 | 4.3 J | 20 | 1400 | 10 U | 50 U | 34000 | 3.8 J | 630 | 0.096 U | 23 J | 5.4 J | 16 U |
| PZ-205-SS | 8/3/2012 | Dissolved | 200 U | 10 U | 10 U | 130 | 10 U | 50 U | 77 U | 1.6 J | 15 U | 0.20 U | 40 U | 50 U | 15 J |
| PZ-205-SS | 8/3/2012 | Total | 80 J | 10 U | 10 U | 140 | 10 U | 50 U | 120 | 10 U | 15 U | 0.066 U | 40 U | 50 U | 15 U |
| PZ-206-SS | 8/7/2012 | Dissolved | 1000 U | 50 U | 50 U | 76 J | 50 U | 250 U | 200 J | 50 U | 51 J | 0.20 U | 200 U | 250 U | 34 J |
| PZ-206-SS | 8/7/2012 | Total | 2900 | 10 U | 10 U | 110 | 6.7 J | 4.8 J | 5700 | 5.9 J | 110 | 0.20 U | 15 J | 11 J | 46 |
| PZ-207-AS | 8/8/2012 | Dissolved | 1000 U | 50 U | 12 U | 660 | 50 U | 250 U | 19000 | 50 U | 66 J | 0.2 UJ- | 200 | 250 U | 100 U |
| PZ-207-AS | 8/8/2012 | Total | 110 J+ | 10 U | 5.4 J | 700 | 3.4 J | 5.9 J | 22000 | 4.9 J | 71 | 0.16 UJ- | 40 | 4.7 J | 63 |
| PZ-208-SS | 8/2/2012 | Dissolved | 200 U | 10 U | 10 U | 160 | 10 U | 50 U | 65 J | 1.9 J | 28 | 0.20 U | 40 U | 50 U | 13 U |
| PZ-208-SS | 8/2/2012 | Total | 3000 J+ | 10 U | 10 U | 180 | 10 U | 50 U | 4200 J | 6.5 J | 40 J+ | 0.20 U | 40 U | 8.0 J | 39 J+ |
| PZ-302-AI | 8/9/2012 | Dissolved | 1000 U | 50 U | 50 U | 310 | 50 U | 250 U | 1700 | 50 U | 210 | 0.2 U | 200 U | 250 U | 100 U |
| PZ-302-AI | 8/9/2012 | Total | 1500 | 50 U | 13 U | 310 | 50 U | 20 J | 4900 | 50 U | 210 | 0.2 UJ- | 200 U | 250 U | 54 U |
| PZ-303-AS | 8/10/2012 | Dissolved | 1000 U | 50 U | 90 | 650 | 50 U | 250 U | 66000 | 8.0 J | 1700 | 0.2 U | 200 U | 250 U | 100 U |
| PZ-303-AS | 8/10/2012 | Total | 400 J | 50 U | 88 | 770 | 50 U | 250 U | 78000 | 9.5 J | 1800 | 0.2 UJ- | 200 U | 250 U | 100 U |
| PZ-304-AI | 8/10/2012 | Dissolved | 1000 U | 50 U | 15 U | 1600 | 50 U | 250 U | 17000 | 50 U | 1300 | 0.2 U | 200 U | 250 U | 100 U |
| PZ-304-AI | 8/10/2012 | Total | 1000 U | 50 U | 50 U | 1700 | 50 U | 250 U | 22000 | 13 J | 1500 | 0.2 UJ- | 200 U | 250 U | 100 U |
| PZ-304-AS | 8/10/2012 | Dissolved | 1000 U | 50 U | 230 | 1500 | 50 U | 250 U | 24000 | 50 U | 92 | 0.2 U | 200 U | 250 U | 100 U |
| PZ-304-AS | 8/10/2012 | Total | 490 J | 50 U | 210 | 1600 | 50 U | 250 U | 26000 | 50 U | 94 | 0.2 UJ- | 69 J | 250 U | 100 U |
| PZ-305-AI | 8/8/2012 | Dissolved | 1000 U | 50 U | 36 U | 610 | 50 U | 250 U | 38000 | 50 U | 4000 | 0.2 UJ- | 200 U | 250 U | 100 U |
| PZ-305-AI | 8/8/2012 | Total | 980 J+ | 10 U | 26 | 670 | 10 U | 50 U | 44000 | 3.8 J | 4100 | 0.2 UJ- | 40 U | 8.5 J | 22 U |

Table 14: Summary of Detected Trace Metal Results

| | Sample | Sample | Alumi- | Anti- | | | Chro- | | | | Manga- | Mer- | | Vana- | |
|-----------|--------|----------|--------|-------|---------|--------|-------|--------|------|------|--------|------|--------|-------|------|
| Sample ID | Date | Fraction | num | mony | Arsenic | Barium | mium | Cobalt | Iron | Lead | nese | cury | Nickel | dium | Zinc |

Notes:

All values are in units of micrograms per liter (ug/l)

DUP = Duplicate samples; Field duplicates were collected from the following locations: DUP 01 = PZ-201A-SS, DUP 02 = PZ-200-SS, DUP 03 = PZ-113-Ad, DUP-04 = D-6, DUP-05 = D-3, DUP 06 = D-13, DUP 07 = LR-104, and DUP 08 = I-9.

Data Validation Qualifiers (Final Q) include:

U = non-detect at the reported value

J = estimated result

J+ = estimated result which may be biased high

J- = estimated result which may be biased low

UJ = non-detect at the estimated reported value

UJ- = non-detect at the estimated reported value which may be biased low

Table 15: Summary of Most Frequently Detected Volatile Organic Compounds

| | | 1,2- | 1,4- | | | cis-1,2- | Methyl tert- |
|------------|-------------|-----------------|-----------------|---------|---------------|----------------|--------------|
| Sample ID | Sample Date | Dichlorobenzene | Dichlorobenzene | Benzene | Chlorobenzene | Dichloroethene | butyl ether |
| S-5 | 8/14/2012 | 1.3 J | 10 | 3.8 J | 1.3 J | 5 U | 0.86 J |
| S-8 | 8/9/2012 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| S-10 | 8/8/2012 | 0.29 J | 0.76 J | 3.2 J | 5.5 | 1.9 J | 0.66 J |
| S-61 | 8/7/2012 | 5.0 UJ | 5.0 UJ | 5.0 UJ | 5.0 UJ | 1.0 J- | 5.0 UJ |
| S82 | 8/10/2012 | 5 U | 5 U | 0.31 J | 5 U | 2.7 J | 5 U |
| S-84 | 8/6/2012 | 5 U | 5 U | 1.6 J | 9.9 | 0.66 J | 5 U |
| D-3 | 8/8/2012 | 5 U | 5 U | 0.50 J | 2.4 J | 5 U | 0.50 J |
| D-3 DUP | 8/8/2012 | 5 U | 5 U | 0.53 J | 5.1 | 5 U | 0.51 J |
| D-6 | 8/7/2012 | 5.0 UJ | 5.0 UJ | 5.0 UJ | 5.0 UJ | 0.42 J- | 8.7 J- |
| D-6 DUP | 8/7/2012 | 5.0 UJ | 5.0 UJ | 5.0 UJ | 5.0 UJ | 0.50 J- | 8.9 J- |
| D-12 | 8/8/2012 | 5 U | 5 U | 5 U | 1.2 J | 0.44 J | 0.52 J |
| D-13 | 8/10/2012 | 5 U | 5 U | 5 U | 5 U | 5 U | 13 |
| D-13 DUP | 8/10/2012 | 5 U | 5 U | 5 U | 5 U | 5 U | 15 |
| D-81 | 8/9/2012 | 5 U | 5 U | 5 U | 5 U | 2.6 J | 5 U |
| D-83 | 8/9/2012 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| D-85 | 8/6/2012 | 5 UJ | 5 UJ | 0.35 J | 60 J | 0.18 J | 5 UJ |
| D-87 | 8/1/2012 | 5.0 U | 5.0 U | 0.57 J | 5.0 U | 0.70 J | 5.0 U |
| D-93 | 8/14/2012 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| LR-104 DUP | 8/13/2012 | 5 U | 5 U | 5 U | 5 U | 0.56 J | 5 U |
| 1-4 | 8/14/2012 | 0.69 J | 2.5 J | 1.7 J | 8.7 | 5.U | 0.78 J |
| 1-9 | 8/14/2012 | 5 U | 5 U | 0.68 J | 5 U | 5.4 | 5 U |
| I-9 DUP | 8/14/2012 | 5 U | 5 U | 0.63 J | 5 U | 5.4 | 5 U |
| I-11 | 8/8/2012 | 5 U | 5 U | 5 U | 19 | 1.9 J | 0.55 J |
| 1-62 | 8/9/2012 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1-65 | 8/6/2012 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| I-66 | 8/10/2012 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1-67 | 8/10/2012 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1-68 | 8/6/2012 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| I-73 | 8/4/2012 | 5.0 U | 5.0 U | 2.7 J | 0.71 J | 16 | 5.0 U |
| LR-100 | 8/13/2012 | 0.54 J | 6.9 | 6.7 | 87 | 5 U | 5 U |
| LR-103 | 8/13/2012 | 5 U | 5 U | 5 U | 5 U | 0.39 J | 5 U |
| LR-104 | 8/13/2012 | 5 U | 5 U | 5 U | 5 U | 0.52 J | 5 U |
| LR-105 | 8/1/2012 | 0.77 J | 26 | 8.1 | 180 | 5.0 U | 0.62 J |

Table 15: Summary of Most Frequently Detected Volatile Organic Compounds

| | | 1,2- | 1,4- | | | cis-1,2- | Methyl tert- |
|---------------|-------------|-----------------|-----------------|---------|---------------|----------------|--------------|
| Sample ID | Sample Date | Dichlorobenzene | Dichlorobenzene | Benzene | Chlorobenzene | Dichloroethene | butyl ether |
| MW-102 | 8/7/2012 | 5.0 UJ | 5.0 UJ | 5.0 UJ | 5.0 UJ | 5.0 UJ | 5.0 UJ |
| MW-103 | 8/11/2012 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| MW-104 | 8/9/2012 | 5 U | 5 U | 0.27 J | 5 U | 0.27 J | 5 U |
| MW-1204 | 8/2/2012 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 0.97 J |
| P-303-AS | 8/10/2012 | 2.7 J | 0.85 J | 48 | 5 U | 1.2 J | 0.65 J |
| PZ-100-KS | 8/16/2012 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| PZ-100-SD | 7/31/2012 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-100-SS | 7/31/2012 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-101-SS | 8/7/2012 | 5.0 UJ | 0.69 J- | 1.6 J- | 4.9 J- | 5.0 UJ | 0.52 J- |
| PZ-102R-SS | 8/13/2012 | 5 U | 5 U | 5 U | 0.44 J | 5 U | 5 U |
| PZ-102-SS | 8/13/2012 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| PZ-103-SS | 8/7/2012 | 5.0 UJ | 5.0 UJ | 5.0 UJ | 5.0 UJ | 5.0 UJ | 5.0 UJ |
| PZ-104-KS | 8/15/2012 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| PZ-104-SD | 8/1/2012 | 5.0 U | 1.6 J | 120 | 5.0 U | 5.0 U | 1.5 J |
| PZ-104-SS | 8/1/2012 | 5.0 U | 4.0 J | 470 | 5.0 U | 5.0 U | 2.2 J |
| PZ-105-SS | 8/1/2012 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-106-KS | 8/14/2012 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| PZ-106-SD | 7/31/2012 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-106-SS | 7/31/2012 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-107-SS | 8/3/2012 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 0.59 J |
| PZ-109-SS | 8/2/2012 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-110-SS | 8/2/2012 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 2.6 J | 5.0 U |
| PZ-111-KS | 8/13/2012 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| PZ-111-SD | 8/1/2012 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-112-AS | 8/8/2012 | 19 | 17 | 58 | 2800 | 5 U | 0.56 J |
| PZ-113-AD | 8/3/2012 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 0.48 J |
| PZ-113-AD DUP | 8/3/2012 | 5.0 U | 5.0 U | 6.0 | 6.6 | 5.0 U | 5.0 U |
| PZ-113-AS | 8/8/2012 | 5 U | 5 U | 0.33 J | 5 U | 5 U | 1.5 J |
| PZ-113-SS | 8/4/2012 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-114-AS | 7/31/2012 | 0.32 J | 3.1 J | 3.5 J | 25 | 0.52 J | 5.0 U |
| PZ-115-SS | 7/31/2012 | 5.0 U | 5.0 U | 5.0 U | 0.74 J | 5.0 U | 5.0 U |
| PZ-116-SS | 8/3/2012 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-200-SS | 8/2/2012 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |

Table 15: Summary of Most Frequently Detected Volatile Organic Compounds

| | | 1,2- | 1,4- | | | cis-1,2- | Methyl tert- |
|----------------|-------------|-----------------|-----------------|---------|---------------|----------------|--------------|
| Sample ID | Sample Date | Dichlorobenzene | Dichlorobenzene | Benzene | Chlorobenzene | Dichloroethene | butyl ether |
| PZ-200-SS DUP | 8/2/2012 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-201A-SS | 8/1/2012 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-201A-SS DUP | 8/1/2012 | 0.51 J | 0.44 J | 5.0 U | 1.1 J | 5.0 U | 5.0 U |
| PZ-202-SS | 8/2/2012 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-203-SS | 8/1/2012 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-204A-SS | 8/2/2012 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-204-SS | 8/3/2012 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-205-AS | 8/3/2012 | 5.0 U | 5.0 U | 5.6 | 6.9 | 0.22 J | 5.0 U |
| PZ-205-SS | 8/3/2012 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-206-SS | 8/7/2012 | 5.0 UJ | 5.0 UJ | 5.0 UJ | 5.0 UJ | 0.23 J- | 5.0 UJ |
| PZ-207-AS | 8/8/2012 | 0.49 J | 3.0 J | 1.6 J | 13 | 5 U | 1.0 J |
| PZ-208-SS | 8/2/2012 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 0.53 J | 5.0 U |
| PZ-302-AI | 8/9/2012 | 5 U | 5 U | 5 U | 5 U | 0.38 J | 5 U |
| PZ-304-AI | 8/10/2012 | 5 U | 5 U | 3.9 J | 27 | 2.0 J | 5 U |
| PZ-304-AS | 8/10/2012 | 5 U | 5 U | 8.2 | 44 | 5 U | 5 U |
| PZ-305-AI | 8/8/2012 | 5 U | 5 U | 1.4 J | 4.6 J | 5 U | 5 U |

Notes:

All values are in units of micrograms per liter (ug/l)

DUP = Duplicate samples; Field duplicates were collected from the following locations: DUP 01 = PZ-201A-SS, DUP 02 = PZ-200-SS, DUP 03 = PZ-113-Ad, DUP-04 = D-6, DUP-05 = D-3, DUP 06 = D-13, DUP 07 = LR-104, and DUP 08 = I-9.

Data Validation Qualifiers (Final Q) include:

U = non-detect at the reported value

J = estimated result

J- = estimated result which may be biased low

UJ = non-detect at the estimated reported value

Table 16: Summary of Detected Semivolatile Organic Compounds

| Sample ID | Sample Date | Analyte | Result | Final Q |
|-----------|-------------|-----------------------------|--------|---------|
| MW-103 | 8/11/2012 | 1,2,4-Trichlorobenzene | 4.7 | J |
| MW-103 | 8/11/2012 | 1,2-Dichlorobenzene | 1.8 | j |
| MW-103 | 8/11/2012 | 1,3-Dichlorobenzene | 1.7 | J |
| PZ-104-SD | 8/1/2012 | 1,4-Dichlorobenzene | 1.0 | j |
| PZ-112-AS | 8/8/2012 | 1,4-Dichlorobenzene | 11 | |
| PZ-114-AS | 7/31/2012 | 1,4-Dichlorobenzene | 2.0 | j |
| PZ-207-AS | 8/8/2012 | 1,4-Dichlorobenzene | 2.4 | j |
| S-5 | 8/14/2012 | 1,4-Dichlorobenzene | 5.2 | J |
| 1-4 | 8/14/2012 | 1,4-Dichlorobenzene | 1.3 | j |
| LR-105 | 8/1/2012 | 1,4-Dichlorobenzene | 19 | |
| PZ-104-SS | 8/1/2012 | 1,4-Dichlorobenzene | 2.1 | J |
| PZ-304-AI | 8/10/2012 | 1,4-Dichlorobenzene | 1.6 | J |
| PZ-304-AS | 8/10/2012 | 1,4-Dichlorobenzene | 7.4 | J |
| LR-100 | 8/13/2012 | 1,4-Dichlorobenzene | 4.4 | J |
| MW-103 | 8/11/2012 | 2,4-Dimethylphenol | 120 | |
| PZ-104-SD | 8/1/2012 | 2,4-Dimethylphenol | 1.1 | J |
| LR-105 | 8/1/2012 | 2,4-Dimethylphenol | 65 | |
| PZ-112-AS | 8/8/2012 | 2-Chlorophenol | 9.8 | |
| LR-105 | 8/1/2012 | 2-Methylnaphthalene | 1.0 | J |
| MW-103 | 8/11/2012 | 2-Methylnaphthalene | 47 | |
| LR-100 | 8/13/2012 | 2-Methylnaphthalene | 2.4 | J |
| MW-103 | 8/11/2012 | 2-Methylphenol | 3.4 | J |
| PZ-104-SD | 8/1/2012 | 3 & 4 Methylphenol | 54 | |
| 1-68 | 8/6/2012 | Benzo[b]fluoranthene | 1.3 | J |
| PZ-104-SS | 8/1/2012 | Bis(2-ethylhexyl) phthalate | 1.4 | J |
| S-5 | 8/14/2012 | Bis(2-ethylhexyl) phthalate | 7.1 | J |
| PZ-207-AS | 8/8/2012 | Bis(2-ethylhexyl) phthalate | 28 | |
| D-87 | 8/1/2012 | Bis(2-ethylhexyl) phthalate | 1.1 | J |
| PZ-104-SD | 8/1/2012 | Bis(2-ethylhexyl) phthalate | 1.2 | J |
| MW-103 | 8/11/2012 | Bis(2-ethylhexyl) phthalate | 9.3 | J |
| LR-105 | 8/1/2012 | Bis(2-ethylhexyl) phthalate | 12 | |
| PZ-100-SS | 7/31/2012 | Bis(2-ethylhexyl) phthalate | 0.96 | J |
| LR-100 | 8/13/2012 | Bis(2-ethylhexyl) phthalate | 120 | |
| LR-105 | 8/1/2012 | Butyl benzyl phthalate | 1.4 | J |
| PZ-101-SS | 8/7/2012 | Dimethyl phthalate | 1.5 | J- |
| PZ-113-AS | 8/8/2012 | Dimethyl phthalate | 1.8 | j |
| D-12 | 8/8/2012 | Dimethyl phthalate | 1.8 | j |
| PZ-103-SS | 8/7/2012 | Dimethyl phthalate | 4.3 | J- |
| MW-103 | 8/11/2012 | Di-n-butyl phthalate | 7.2 | j |
| LR-100 | 8/13/2012 | Di-n-octyl phthalate | 5.3 | j |
| I-68 | 8/6/2012 | Fluoranthene | 1.3 | j |
| 1-68 | 8/6/2012 | Indeno[1,2,3-cd]pyrene | 3.6 | J |
| LR-105 | 8/1/2012 | Naphthalene | 11 | |
| S-5 | 8/14/2012 | Naphthalene | 6.6 | J |

12/14/201

Table 16: Summary of Detected Semivolatile Organic Compounds

| Sample ID | Sample Date | Analyte | Result | Final Q |
|-----------|-------------|------------------------|--------|---------|
| MW-103 | 8/11/2012 | Naphthalene | 56 | |
| LR-100 | 8/13/2012 | Naphthalene | 1.3 | J |
| PZ-112-AS | 8/8/2012 | Naphthalene | 220 | |
| LR-100 | 8/13/2012 | N-Nitrosodiphenylamine | 2.5 | J |
| PZ-207-AS | 8/8/2012 | N-Nitrosodiphenylamine | 1.9 | J |
| LR-105 | 8/1/2012 | N-Nitrosodiphenylamine | 1.1 | j |
| MW-103 | 8/11/2012 | Phenanthrene | 1.8 | j |
| LR-100 | 8/13/2012 | Phenanthrene | 1.4 | J |
| LR-105 | 8/1/2012 | Phenol | 2.4 | J |
| P-303-AS | 8/10/2012 | Phenol | 3.1 | J |
| LR-100 | 8/13/2012 | Phenol | 2.0 | J |
| PZ-102-SS | 8/13/2012 | Phenol | 2.9 | J |
| PZ-304-AS | 8/10/2012 | Phenol | 2.7 | J |
| I-68 | 8/6/2012 | Pyrene | 1.1 | j |

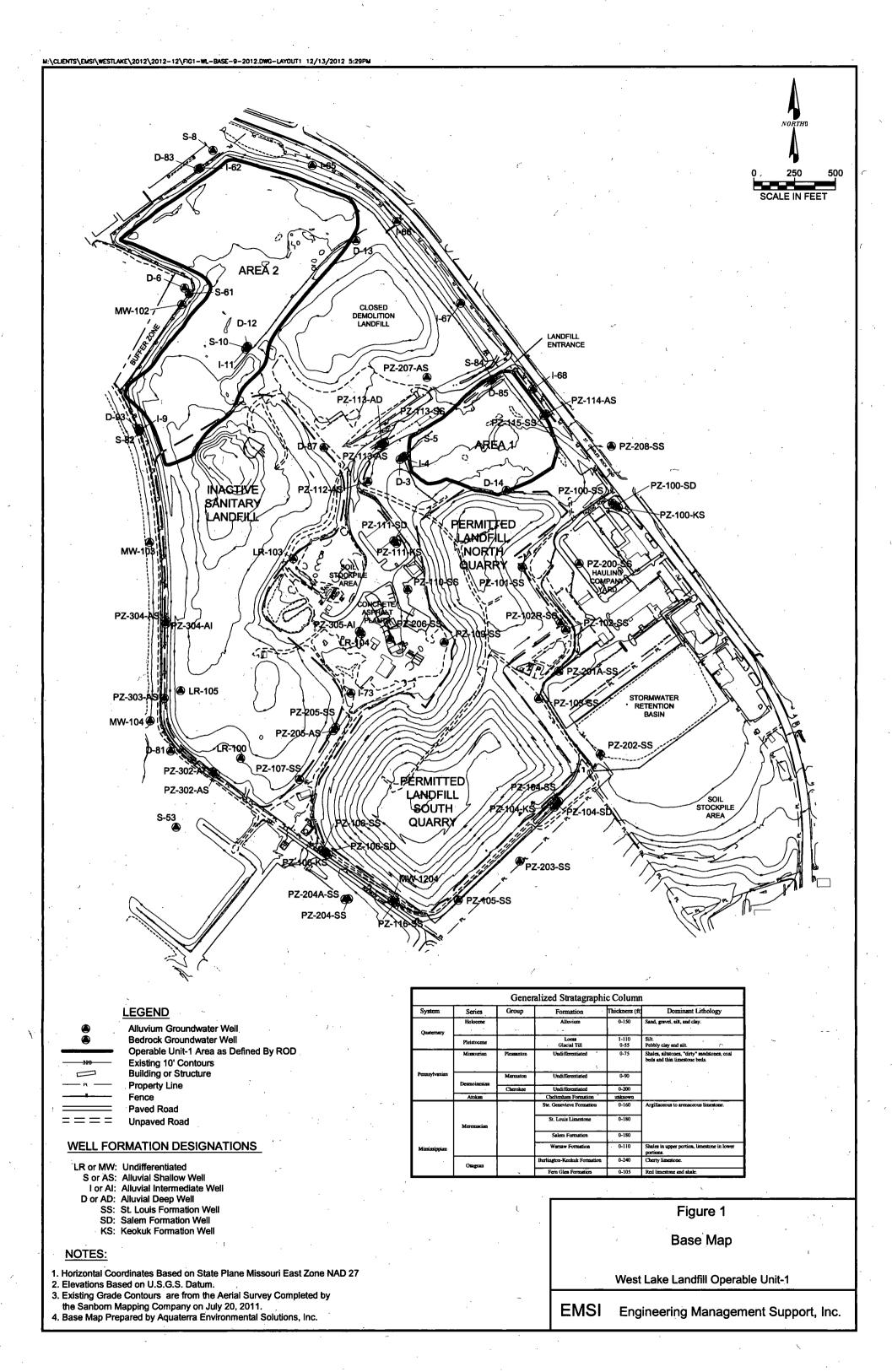
Notes:

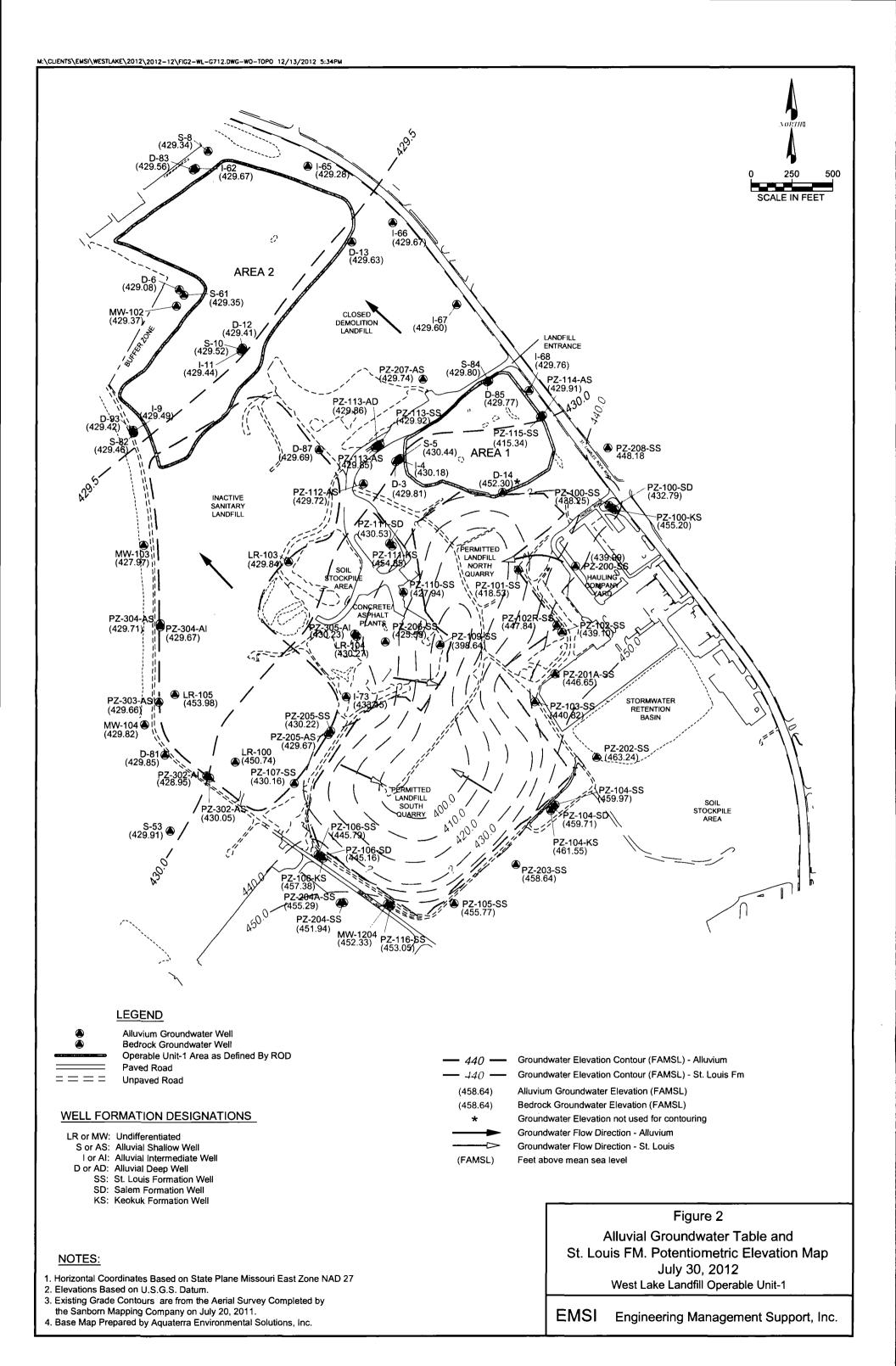
All values are in units of micrograms per liter (ug/l) Data Validation Qualifiers (Final Q) include:

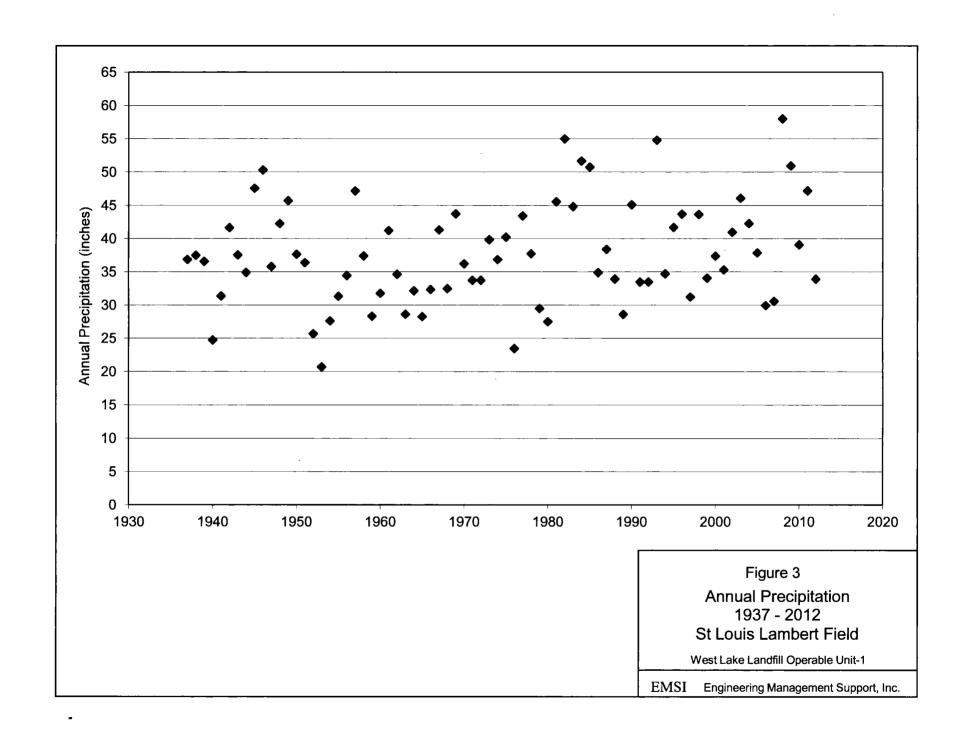
J = estimated result

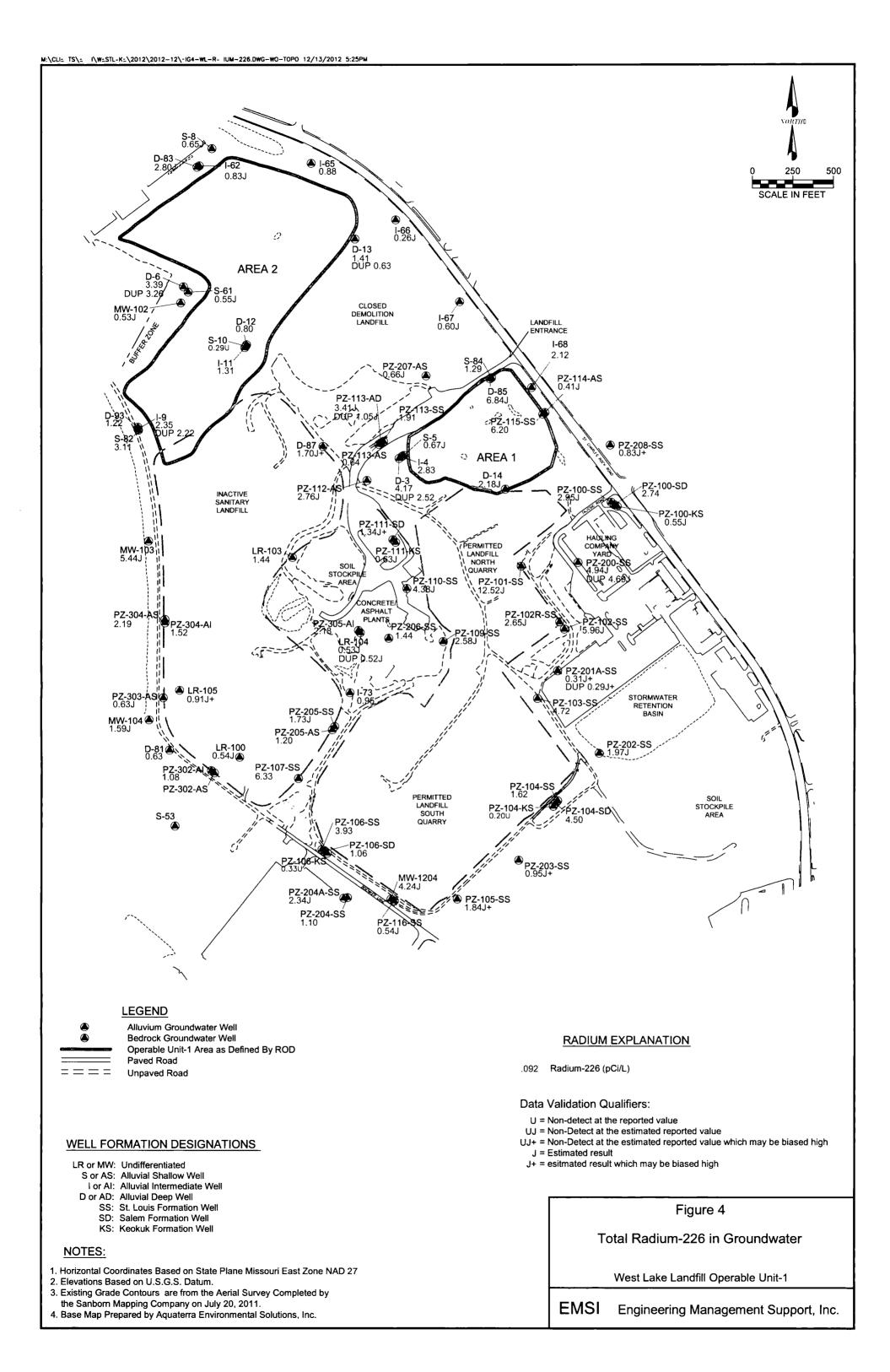
J- = estimated result which may be biased low

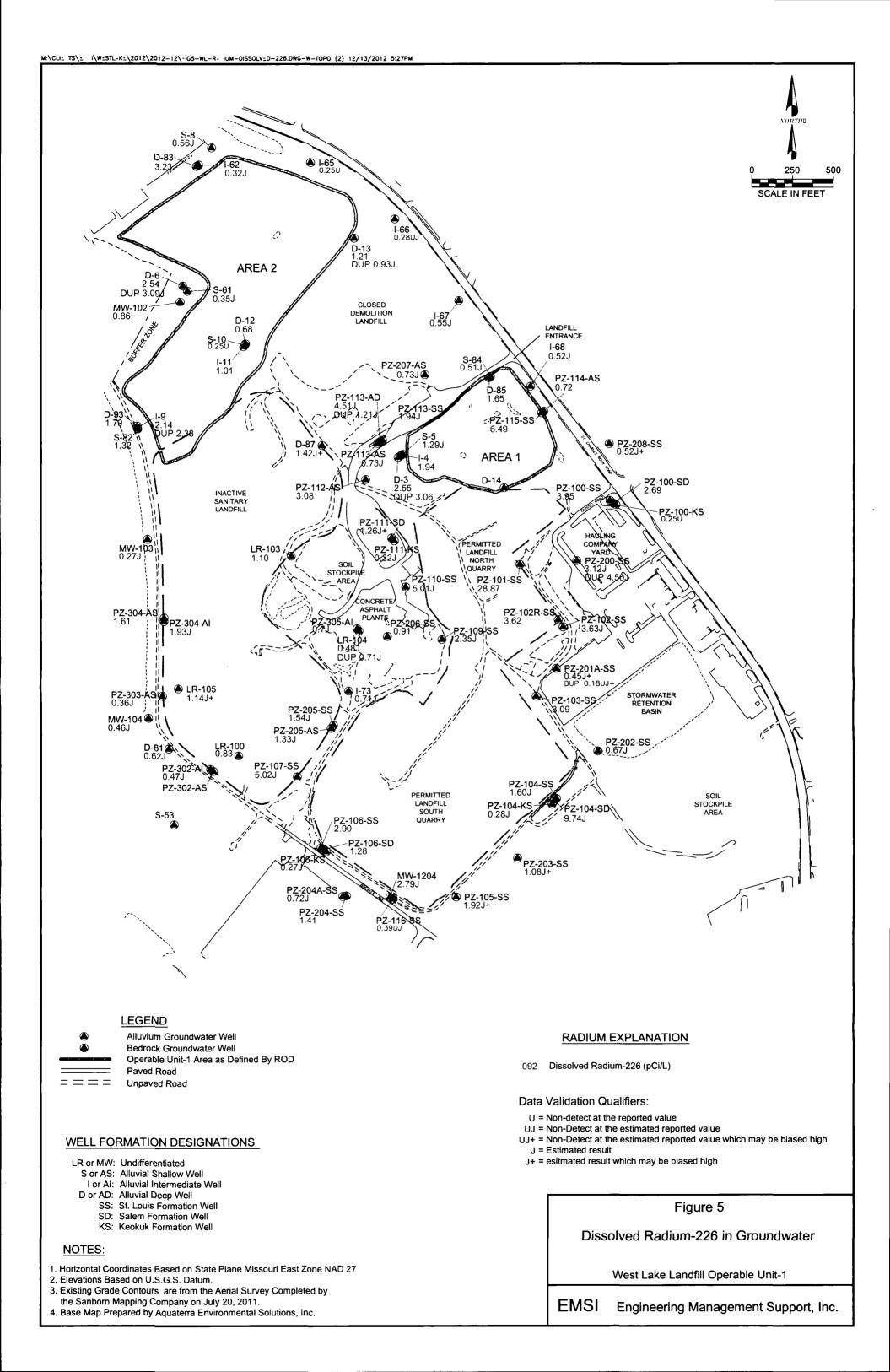


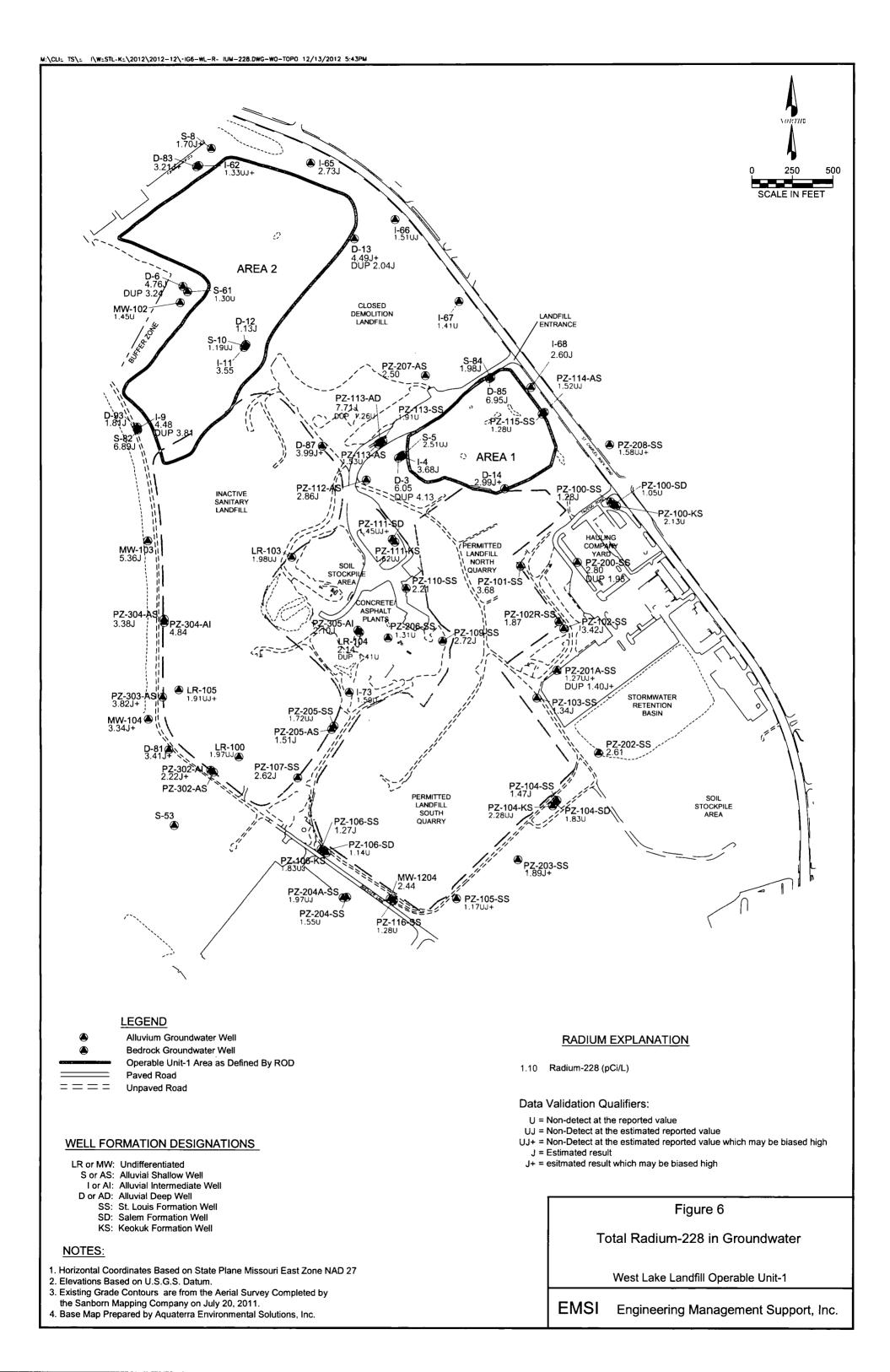










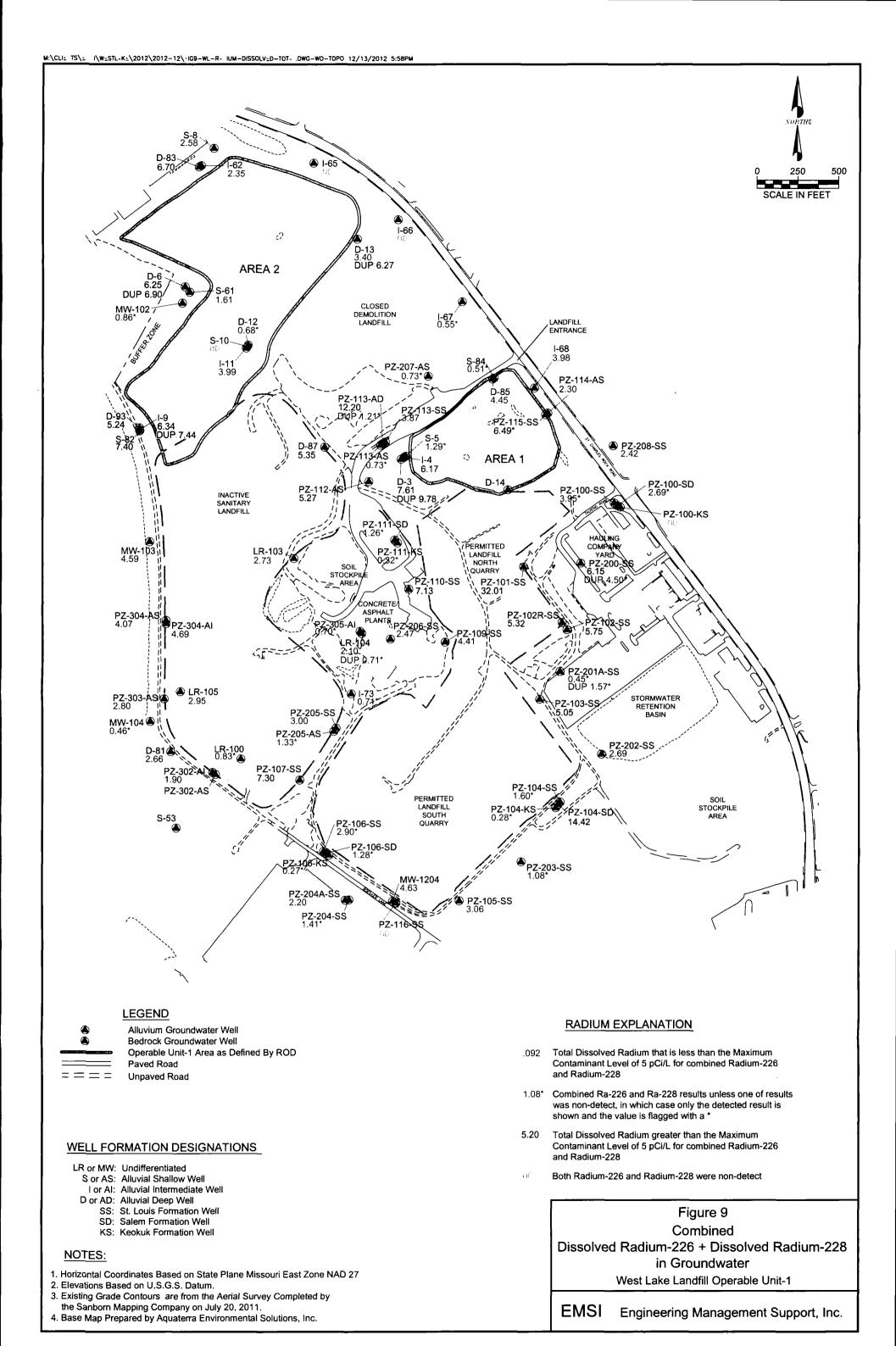


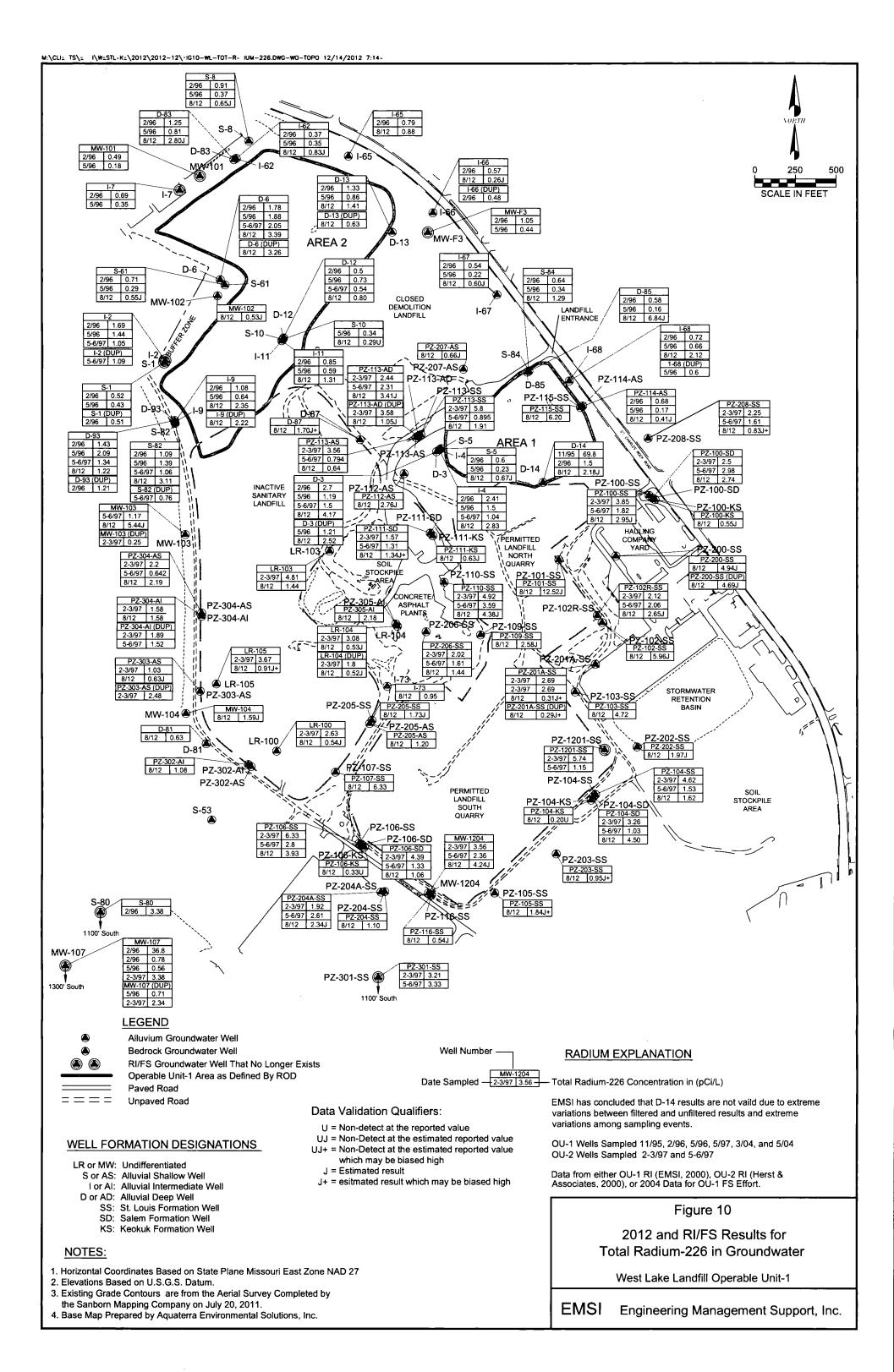
NOTES:

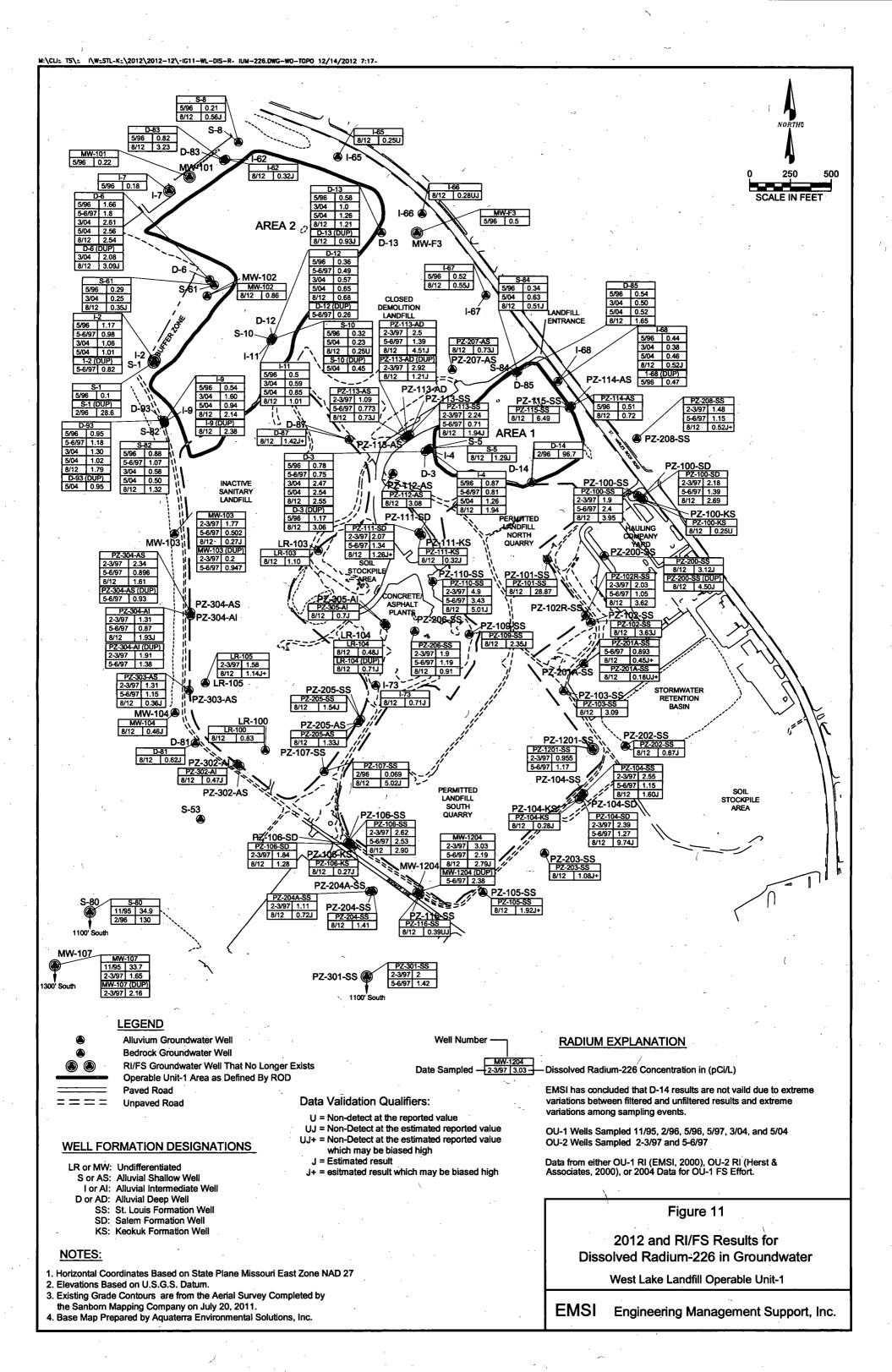
- 1. Horizontal Coordinates Based on State Plane Missouri East Zone NAD 27
- 2. Elevations Based on U.S.G.S. Datum.
- Existing Grade Contours are from the Aerial Survey Completed by the Sanborn Mapping Company on July 20, 2011.
- 4. Base Map Prepared by Aquaterra Environmental Solutions, Inc.

Total Radium-226 + Total Radium-228
in Groundwater
West Lake Landfill Operable Unit-1

EMSI Engineering Management Support, Inc.







Appendices
(on compact disk)

March 14, 2013

Risk and Character of Radioactive Waste at the West Lake Landfill, Bridgeton, Missouri

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Summary

In 1973, 8700 tons of radionuclide-bearing "leached barium sulfate" was allegedly dumped in an unlined landfill in Bridgeton, MO that was not licensed to receive radwaste. This report finds that 1) the chemical and physical character of the radioactive material has not been adequately characterized, and barium sulfate is probably not a major constituent; 2) the alpha and beta emissions of this material will increase 10x to 100x over present levels, reaching maximum activity in about 9000 years; 3) the landfill has no protective barriers and a proximal subsurface fire; 4) the site has several hydrologic and geologic risk factors that magnify its unsatisfactory location in a populated area; 5) nuclear material has been in contact with percolating waters and with a fluctuating water table; 6) groundwaters contaminated with radionuclides have migrated far from the original location of disposal; 7) background levels of radiation have been overstated, while other risks have been underestimated; and 8) neither the potentially responsible parties nor EPA have acquired essential data, have properly interpreted their data, or considered relevant reports published by disinterested parties. These items are addressed in order below, followed by some recommendations.

1. Chemical and physical character of the radioactive material

According to NRC (1982, p. 4), in 1973 approximately 8700 tons of "leached barium sulfate" containing approximately 7 tons of U_3O_8 were "erroneously dumped" by Cotter Corporation in the West Lake Landfill. Allegedly, this material originated at Mallinckrodt Chemical Works in downtown St. Louis, where uranium was extracted from ore for the Manhattan Project (e.g., NAP, 1995, p. 7). Surplus radioactive materials and processing wastes were subsequently moved several times, first to the "Airport Site" along Coldwater Creek, north of Lambert Field, then to the Latty Avenue Site, east of the airport and also on Coldwater Creek, and finally, some of this hazardous material was delivered to West Lake Landfill, following admixture of an estimated 39,000 tons of "soil" for dilution (NRC, 1988, p. 1).

No available reports mention any accurate analysis of the chemical, physical or radiological character of the radioactive materials dumped at West Lake. Note that neither barium nor sulfate are contaminants of concern, nor is the uranium concentration of the radwaste, alleged to be similar to that of low-grade uranium ore, of primary environmental importance. Instead, the real concerns involve the concentrations of the short-lived, daughter radionuclides in the ²³⁸U, ²³⁵U and ²³²Th decay chains, particularly ²³⁰Th, ²²⁶Ra, ²²⁸Ra, ²²³Ra, ²¹⁰Po, and three daughter radon isotopes, in the radwaste that was dumped. It is likely that complete analyses of the original radwaste, and possibly even actual samples of the "leached barium sulfate", exist today. Also of primary concern is the physical nature of the radwaste, particularly the texture, surface character and grain size of the "barium sulfate", as these properties have essential bearing on how readily radionuclides can be released from this material into percolating waters and ground waters.

NRC (1982, p. 20) concludes "Chemical analyses reveal high concentrations of barium and sulfates in the radioactive deposits. These results tend to confirm the reports that this contaminated material is uranium and uranium ore, contained in leached barium sulfate residues, and presumably transferred

from the Latty Avenue Site in Hazelwood, Missouri." This statement is simplistic and untrue, and in a later report, NRC (1988, p. 11) points out that material with extremely high ²³⁰Th to ²²⁶Ra ratios, up to 300:1, "might have been transferred along with the barium sulfate residues." First, the barium (< 2500 ppm) and sulfate (< 125 ppm) concentrations in five samples of the contaminated material (see NRC, 1982, Table 13, p. 109) are far too low, by ~100x and ~1000x respectively, than concentrations expected for material containing appreciable amounts of barium sulfate. Second, the barium to sulfate ratios of these samples range from about 17: 1 to 105: 1, when stoichiometric barium sulfate has a Ba:SO₄ weight ratio of only 1.43: 1. It is thus very likely that a large amount, if not most, of the radionuclides at West Lake are not contained in barium sulfate, but instead are incorporated in other types of processing waste that could be far more reactive, soluble and leachable than barium sulfate.

Instead of addressing this primary issue, numerous reports have focused on analyzing and interpreting samples of landfill dirt, ambient air, ground and surface waters, etc. While these costly and continuing efforts have provided some useful information about environmental site hazards, they cannot answer the key question, which is, what type of radwaste was originally dumped at West Lake Landfill?

2. Radiological character of waste

Available data and surveys provide the following information about the West Lake radwaste:

NRC (1988, p. 12, 13) estimates that landfill wastes contain an average concentration of about 90 pCi/g, and that the site contains a total activity of approximately 3 Ci due to ²³⁸U, 3 Ci due to ²³⁴U, 1400 Ci due to ²³⁰Th, and 14 Ci due to ²²⁶Ra decay. Both ²²²Rn and ²¹⁹Rn were detected, as well as ²²⁶Ra and ²²³Ra, so products of both the ²³⁸U and ²³⁵U decay chains are present at the site (NRC, 1982, p. 13; also Table 5). Elevated ²²⁸Ra is also present, which is part of the ²³²Th decay chain (EMSI, 2012, Figs. 6, 7). Involvement of these three decay chains means that a minimum of 46 different radionuclides representing 12 different elements are present at West Lake Landfill (e.g., Faure, 1986).

Onsite ²²⁶Ra concentrations in soils as high as 21,000 pCi/g were measured, compared to estimated background levels of 2 pCi/g (NRC 1982, p. 13). Elevated radium contents above the EPA's MCL of 5 pCi/l are also widespread in both the alluvial and bedrock aquifer within about 1500 feet of Areas 1 and Area 2 (e.g., EMSI, 2012, Figs. 8, 9). Airborne surveys established that external radiation levels exceeding 100µR/hr (NRC, 1982, p. 5), while distal samples were <10 µR/hr (Fig. 2, p. 26). Levels recorded one meter above Area 2 were as high as 3-4 mR/hr, or as much as 400x higher than background (NRC 1982, p. 11). NRC (1982, p11) reports that the subsequent addition of soil cover and construction debris to Areas 1 and 2 diminished these levels several fold.

All surface soil samples "contain high levels of ²³⁰Th. The ratio of ²³⁰Th to ²²⁶Ra is about 20..." (NRC, 1982, p. 14). Elsewhere the ²³⁰Th to ²²⁶Ra ratio is reported to be "5 to 50" (NRC, 1982, p. 20), or "4:1 to 40:1" but also that samples "along the berm range up to 70:1" (NRC, 1988, p. 11). NRC (1988, p. 14) also points out that "... the large but variable ratio of Th-230 to Ra-226 and its decay products makes the delineation of cleanup more difficult. When the ratio is so large (20:1 or more), even a small concentration of Ra-226 in 1988 implies such a large concentration later that it will be necessary to employ more difficult measurements to confirm that the cleanup has been satisfactory."

Importantly, because the concentrations of short-lived radionuclides will progressively increase, the radioactivity at the site will likewise increase for the foreseeable future. For example, according to NRC (1988, p. 13), if the present day activity of ²³⁰Th is estimated to be 100 times that of ²²⁶Ra, then

the alpha activity due to ²²⁶Ra decay will increase fivefold over present levels in 100 years, nine-fold in 200 years, and 35-fold in 1000 years. The following equation and figure were developed to clarify this problem:

$$\frac{^{226}Ra}{^{226}Ra_{pd}} = \left(\frac{^{230}Th}{^{226}Ra}\right)_{pd} \left(\frac{\lambda_{226}}{\lambda_{226}-\lambda_{230}}\right) \left(e^{-\lambda_{230}t} - e^{-\lambda_{226}t}\right) + e^{-\lambda_{226}t}$$
 Eq. 1

Equation 1. Relationship between the future activity of 226 Ra and elapsed time t for any assumed, present-day (pd) activity ratio of 230 Th to 226 Ra (first term on right, above). The 226 Ra activities are normalized to present day levels in the ratio on the left hand side. Here, λ_{226} and λ_{230} are the well-known decay constants of 226 Ra and 230 Th, which are 4.3E-4/y and 9.0E-6/y, respectively. Additional production of 230 Th by decay of long-lived uranium isotopes is neglected, but such production could only slightly increase the maximum 226 Ra values that will be attained ~ 9000 years from now, while lengthening the time required for the 226 Ra activity to eventually decrease back to present day values.

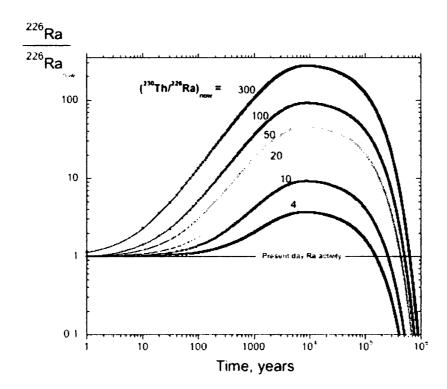


Figure 1. Growth of ²²⁶ Ra activity over present levels, calculated using Eq. 1 as a function of time from now and the present-day ²³⁰Th to ²²⁶Ra activity ratio (labeled curves). The latter is assumed to vary from 4x to 300x, representing the range of measured and estimated values reported by NRC (1982, 1988). Available data and these calculations indicate that alpha radiation emitted by radium-226 in landfill radwaste will increase by a factor of 10x to 100x, attaining a maximum activity about 9000 years from now. Radon-222 concentrations will increase by the same 10x to 100x factor, as will the concentrations and radioactive emanations of many other short-lived radionuclides. After the maximum levels of radioactivity are attained, the activity will slowly return back to present-day values, but this will require several hundred thousand years.

The radioactivity of a nuclide that undergoes decay while simultaneously being produced by decay of a parent radionuclide is easily calculated (e.g., Faure, 1986). I used those well-known results to derive Equation 1, which facilitates direct calculation of future ²²⁶Ra activities, relative to its present-day activity, as a function of time (years) and any assumed, present-day ²³⁰Th to ²²⁶Ra activity ratio. Figure 1 shows that the ²²⁶Ra activity at West Lake Landfill will steadily increase for ~9000 years, when the levels will probably be 10 to 100-times greater than the present-day ²²⁶Ra activity. Of course, each of many subsequent, short-lived radionuclides in the ²³⁸U decay chain will also increase by that same factor of 10 to 100x, including ²²²Rn, ²¹⁸Po, ²¹⁴Bi, ²¹⁰Pb, and others. In fact, every time in the future that an ²²⁶Ra atom disintegrates by releasing an alpha particle, new daughter radionuclides will be generated that will themselves quickly decay, together releasing 4 additional alpha particles, plus 4 beta particles and numerous gamma rays (e.g., see Walker et al., 1989; Faure, 1986).

3. Nature of the landfill

According to NRC (1982, pp. iii, 3), about 15 acres of the West Lake landfill to depths up to 20 feet are contaminated with radwaste, all situated on the alluvial floodplain of the Missouri River. Other chemical wastes, unrelated to the radioactive contamination, are also present including heavy metals, oils and halogenated hydrocarbons (NRC, 1982 p. 5). More recently, EPA (2008, p. 2) concluded that about 10 acres of Radiological Area 1 are impacted by radionuclides at depths ranging up to 15 feet, while about 30 acres of Area 2 are impacted by radionuclides at depths generally ranging to 12 feet. Yet another 4.5 acre area, an adjacent property variously referred to as the "Buffer Zone/Crossroad Property", or the "Ford Property", or the "Farmer's field", has been "superficially contaminated" (EPA, 2008, p. 2, 10), and subsequently has been "scraped and regraded". In spite of this intervention, almost half of the surface soil samples recently collected from this latter area had radionuclide concentrations significantly above background levels (EPA, 2008, p. 17).

West Lake Landfill has no engineering barriers. Specifically, it has no basal clay liner, no plastic sheeting, no internal cells, no leachate collection system, nor any type of protective cap, all of which are standard requirements for modern landfills. Instead, West Lake Landfill is a chaotic pile of debris covered by unmanaged "natural" vegetation, surrounded by a fence with radioactive hazard signs. This landfill is an unsuitable host for any type of radwaste, industrial waste, chemical waste, or even ordinary domestic waste. For example, Figure 3-29 of McLaren Hart (1996) confirms that Area 2 of West Lake Landfill is a 30 to 45 foot-deep pile of material dumped directly on unconsolidated alluvial sand deposits, that in turn overlie Mississippian limestone units.

In addition to the above problems, an underground fire is currently ongoing in the municipal landfill (OU-2) that is immediately south of Area 1 of OU-1. Such fires can burn for years, creating high underground temperatures, and releasing carbon monoxide, dioxins, VOCs and other noxious chemicals, and particulates into air (e.g., EPA 1995, p. 1.3 to 1.6; FEMA, 2002, p. 15). Numerous people who reside near the landfill complained about odor and health problems at the January 17, 2013 public meeting in Bridgeton. Risks for adjacent, radionuclide-bearing OU-1 include but are not restricted to the following 1) fire can spread from OU-2 into OU-1, particularly because demolition and construction landfills are known to have much higher fire risk than municipal landfills (FEMA, 2002, p. 7); 2) subterranean fires can result in landfill collapse, landslides and slumping, endangering personnel and exposing dangerous materials to the surface (FEMA, 2002, p. 5, 25); 3) landfill fires have high explosion risk because of methane, gas cylinders, and drums; 4) high temperatures and smoke could mobilize

radionuclides into surface water, groundwater and air. For example, toxic chemicals and radionuclides including alpha-emitting radon isotopes can become attached to carbon-rich particulates, then disseminated in smoke (e.g., Foss-Smith, 2010); 5) explosions, collapse, and other problems can unearth radionuclides, which can then spread over large areas as airborne dust or in water. This situation exemplifies how both unanticipated risks and unrealistic risk assessments pertain to sites that require isolation of dangerous materials for thousands of years.

4. Hydrologic and Geologic Risk Factors of the West Lake Landfill Site

NRC (1982, p. 3) points out that the West Lake Landfill is located on the Missouri River floodplain, within a combined commercial, rural and industrial area about 1.5 miles from the Missouri River. Several hazards are associated with this site, including flood risk, liquefaction risk, landslide risk, groundwater contamination, a subterranean fire in a proximal landfill, risk of impeding freeway and road traffic, risk of disrupting essential municipal infrastructure or activities, and risk of harm to proximal humans and animals. Attention below is confined to the hydrologic and geologic risks.

EPA (2008, p. 6) argues that flood risk to the landfill is minimal because the area is protected by the "500-year" Earth City levee. Such simplistic statements ignore persuasive evidence that flood levels on the lower Missouri and Mississippi Rivers have been increasing with time (Criss and Shock, 2001), as clearly shown by the actual flood record in Missouri over the last 30 years. Even since 2008, numerous all-time record flood levels have been set along huge reaches of the Missouri and Mississippi Rivers, specifically in northeast Missouri and Iowa in 2008, and in both northwest and southeast Missouri in 2011. Specifically, many sites experienced "100 to 500-year floods" during the last 5 years. As examples, many gaging stations along the Missouri River in northwest Missouri including St. Joseph and Rulo recorded floodwaters within 3 inches of the "500-year" level in 2011. Similarly, floodwaters at Hannibal Missouri rose above the "500-year" level in 1993, and floodwaters at Canton, Missouri exceeded their "500-year" level in both 1993 and 2008. Statistical analysis of actual flood records shows that the recurrence statistics promulgated by the US Army Corps of Engineers (USACE, 2004) typically have less than a 1% chance of being realistic, which means that they have more than a 99% chance of being flat wrong. In fact, the USACE (2004) calculations are so far off that what is commonly called a "100-year" flood can be expected to occur every ten years or so (e.g., Criss, 2008, and refs. within). Given that the radwaste at West Lake Landfill will remain hazardous for many tens of thousands of years (Fig. 1), claims by EPA (2008) that this site is safe from flooding strain credulity.

The West Lake Landfill site is mapped by Missouri DNR as having high liquefaction potential, and as being near areas that have significant landslide potential (Hoffman, 1995). This means that both the landfill and any protective levees can slump or fail during an earthquake, during rainy periods, or during flooding, and would be especially vulnerable if such conditions coincided. During the wet period of May 1995, the northwest side of Area 2 of West Lake landfill underwent erosional scour, and sometime between 1973 and 1996, a "historical slope failure" spread radiologically-contaminated material from Area 2 onto several acres of the adjacent "Ford property" agricultural field (McLaren-Hart, 1996a, pp. 2.2, 3.3; Fig. 1.2). If such failures have happened, they cannot be imaginary.

5. Groundwater Contamination

The Missouri River floodplain is underlain by a productive and important alluvial aquifer, constituted of highly permeable, unconsolidated clastic sediments with a high, fluctuating groundwater table. This aquifer supplies hundreds of irrigation wells and numerous municipalities (e.g., Kelly 1996), and commonly has well yields of 100 to 3000 gpm (Miller and Appel, 1997). The water table in the alluvial aquifer is known to rapidly respond to the river stage as well as to the delivery of recent precipitation, with groundwater rapidly moving either toward or away from the river, depending on the river stage (e.g., Emmett and Jeffrey, 1968; Grannemann and Sharp, 1979; Criss and Criss, 2012). The USGS monitors several observation wells along the lower Missouri River, and these show that the elevation of the water table has varied by 10 to 40 feet within the last few years, depending on the particular site (USGS, 2013).

Because the landfill has no protective cap and no basal liner, any percolating waters can encounter radwaste and then move laterally and downward into the alluvial aquifer, or into the bedrock aquifer in the subjacent Mississippian limestone. Diagrams in McLaren-Hart (1996b; Fig. 3-29) clearly show groundwater in contact with landfill radwaste. Data in EMSI (2012) document that large-scale radionuclide migration in groundwater has occurred (see below).

6. Groundwater migration

NRC (1982, p. 22) concluded that "the buried ore residues are probably not soluble and are not moving off-site via ground water". However, NRC (1988, p. 14-15) subsequently concluded that "some low-level contamination of groundwater is occurring", and that "it is unclear whether the area's groundwater can be protected from onsite disposal".

In contrast, EPA (2008, p. 20) found that only a few of their samples of well water and surface water had Ra concentrations above the drinking water standard (MCL) of 5 pCi/l. Further they concluded that their results "generally show sporadic and isolated detections of a small number of contaminants at relatively low concentration levels," and that "These results are not indicative of on-site contaminant plumes, radial migration, or other forms of contiguous groundwater contamination that might be attributable to the landfill units being investigated."

EMSI (2012, p. iii) parrots EPA's statement about "sporadic and isolated detections ...", yet abundant data in their report contradict it. For example, EMSI (2012, Fig. 5) measured a dissolved ²²⁶Ra concentration of 29 pCi/l, 5 times the MCL, in piezometer PZ-101-SS, located about 500 feet south of the southern boundary of contaminated Area 1. Contrary to their claims (EMSI 2012; p. iii and p. 9), the potentiometric surface map in this report (Fig. 2; EMSI 2012) clearly shows that this piezometer is far downgradient, not "upgradient", of the water table in Area 1, so that the radiological contamination has migrated radially away from Area 1, as well as downward into the Mississippian bedrock aquifer. Abundant additional evidence for migration away from Areas 1 and 2 are provided in the dissolved Ra data shown on the available figures (EMSI, 2012; e.g., Figs. 8, 9).

EMSI (2012, p. 7) also argues that the hydraulic gradient in the alluvial aquifer is very flat, about 0.0004. However, these measurements are not typical as they were made in late July, 2012, in the middle of a protracted drought. Note that NRC (1988, p. 6) reported that the gradient was 0.005 in Nov. 1983 and March 1984, more than 10x greater than the atypical value reported by EMSI (2012). Moreover, numerous studies (e.g., Grannemann and Sharp, 1978) show that both the magnitude and

direction of this gradient rapidly change as the river level varies, which by itself indicates rapid groundwater migration.

EMSI (2012, p. 7) similarly underestimates the hydraulic conductivity of the alluvial aquifer, stating that their measurements indicate that it is only 8.5 to 85 ft/day. For comparison, Emmett and Jeffrey (1968) report a value of 400 ft/day for the hydraulic conductivity of this highly permeable aquifer, while the value determined by recent pump tests (NRC, 2010) are about 750 ft/day. Results in Criss and Criss (2012) for numerous sites along the lower Missouri River are consistent with the values of hydraulic conductivity reported by Emmett and Jeffrey (1968) and NRC (2010), but are clearly not consistent with the low values claimed by EMSI (2012).

The above considerations are highly germane to groundwater migration, because the groundwater velocity is related to the product of the hydraulic gradient and the hydraulic conductivity. Note that EMSI (2012) uses low values for both factors to claim that the "overall velocity of groundwater flow within the alluvium would be 0.0034 to 0.034 ft/day, or 1.2 to 12 ft/year." Instead, the NRC data indicate that the velocity would be more than 100x faster than EMSI's upper limit. It should also be mentioned that these so-calculated "Darcy velocities" are about 4x slower than the actual microscopic velocity of the groundwater, because the real groundwater velocity also depends on the alluvium porosity.

In short, there is no scientific support for the conclusion by EPA (2008, p. 22) that "there is no contaminant plume further downgradient at some off-site location that could be attributable to the source material", nor for their consequent rationalization, "For this reason, off-site groundwater investigations were not undertaken as part of the RI." To the contrary, all available data show that radionuclides are actively migrating in groundwater, and that off-site groundwater investigations are absolutely necessary.

7. Background Radiation Levels

NRC (1982, p. 13) estimates that off-site background levels are 2 pCi/g for 226 Ra, and 0.2 pCi/m²-s for the radon flux (p. 17). NRC (1982, Table 5) and NRC (1988, p. 9) report those levels as ~2.5 pCi/g for offsite soil, but a Rn flux almost 3x higher. NRC (1988, p. 10) estimates that the background level for gross alpha activity in water is 1.5 pCi/l.

For comparison, EMSI (2012, p. 13) measured ²²⁶Ra levels as high as 29 pCi/l in groundwater located peripheral to the West Lake Landfill. They rationalize that these levels are natural, specifically that (p. 13) "the levels of radium detected in the monitoring wells reflect natural occurrences of radium." They further state that "Missouri generally, and the Site specifically, are located within the Ozark Plateau Cambro-Ordivician (MCOO) aquifer system," and cite Szabo et al. (2012) who found that this aquifer system has anomalously high Ra levels.

EMSI (2012) clearly does not understand that the Mississippian bedrock that immediately underlies West Lake Landfill is not part of the "Cambrian-Ordovician" aquifer, correctly spelled here. Moreover, the very top of the "Cambrian-Ordovician" aquifer, also known as the Ozark aquifer, lies about 1,000 feet below West Lake Landfill (e.g., Harrison, 1997). Moreover, the Ozark aquifer is generally separated from overlying Mississippian groundwater by an aquatard, or hydraulic barrier (e.g., Miller et al., 1974; Imes, 1988).

8) Assessment and Recommendations

My analysis of available data indicates the following:

- 1) The chemical and physical character of the radioactive material dumped at West Lake Landfill is unknown. Contrary to longstanding assertions, it appears than no more than a tiny fraction of the dumped radwaste could be "leached barium sulfate".
- 2) The radwaste will become considerably more radioactive for the next \sim 9000 years. Subsequently, that peak level will slowly attenuate, but radioactivity will not diminish to present-day levels for several hundred thousand years.
- 3) Remedial action is necessary, following sufficient study.
- 4) The site has several hydrologic and geologic risk factors that have been underestimated. A proximal underground fire magnifies the risk of radionuclide release, and underscores how unanticipated problems can affect hazardous sites containing materials that require isolation for thousands of years.
- 5) Available data prove that groundwaters have already interacted with radwaste.
- 6) Radiologically-contaminated groundwaters have moved substantial lateral distances away from the original areas where the radwaste was dumped, and also have entered subjacent Mississippian bedrock.
- 7) Regional analyses of gamma radiation, groundwater, sediment and rock are needed to establish meaningful background levels of radioactivity. Inappropriate comparisons in available reports have led to overstatement of local background levels and dismissal of obvious contamination as "natural".
- 8) Additional study of the site is needed. The character of the radioactive materials and processing wastes originally dumped at West Lake Landfill needs to be determined. Relevant, old chemical and radiological analyses of these materials probably exist, and physical samples may still exist. In lieu of these being found, radioactively-contaminated material from the landfill needs to be excavated and collected, processed by standard mineral separation techniques, and then analyzed and examined to determine the chemical, physical and radiological character of the separates of concern. Accurate determination of elemental ratios including Ra/Ba, Ra/U, Ba/U, Th/U, Ba/SO₄, etc. by ICP-MS and other modern techniques would clearly help. Groundwater analyses need to include major elements, physical parameters such as electrical conductivity, and stable isotope data so that radionuclides can be definitively traced to their sources by well-understood methods (e.g., Criss, 1999; Hasenmueller and Criss, 2013). It is not acceptable that so little is known about this radwaste after more than 30 years of "study". Regular monitoring of the levels and radionuclide contents of groundwater also need to be undertaken. Several dozen new monitoring sites must be developed to establish conditions at least 1000 feet away from the landfill boundaries, particularly north and northwest of Area 2, to establish the scale of groundwater contamination and migration.

EPA and the potentially responsible parties need to tend to the above concerns before making recommendations about remediation. They also need to familiarize themselves with abundant published literature that characterizes the hydrogeologic framework of east central Missouri and its

long recognized risk factors. Such effort would provide them with illuminating distinctions between the shallow groundwaters at West Lake Landfill and groundwater in the Ozark aquifer. The same reports would provide them with copious data about how shallow groundwaters along the lower Missouri River respond to river levels and interact with bedrock aquifers, and would correct their misconceptions about the direction that groundwaters flow in response to hydraulic gradients.

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Abbreviations Used in this Report

Ba Barium **Bismuth** Bi Pb Lead Po Polonium Radium Ra Rn Radon SO_4 Sulfate Th Thorium U Uranium U_3O_8 Uranium oxide Volatile organic compounds **VOCs**

Ci Curie

 $\begin{array}{ll} pCi/g & picoCuries \ per \ gram \\ pCi/l & picoCuries \ per \ liter \\ \mu R/hr & microRoentgen \ per \ hour \\ mR/hr & milliRoentgen \ per \ hr \end{array}$

MCL Maximum Contaminant Level

ICP-MS Inductively Coupled Plasma Mass Spectrometry

Executive Summary of the Supplemental Feasibility Study

Radiological-Impacted Material Excavation Alternatives Analysis West Lake Landfill Operable Unit-1

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September 30, 2011

Revised December 16, 2011

Final December 28, 2011

This Executive Summary is not a part of the final Supplemental Feasibility Study approved by EPA but is submitted by the West Lake Landfill OU-1 Respondents to be part of the site file.

Executive Summary

The West Lake Landfill is a 200 acre, closed solid waste disposal facility that accepted wastes for on-site landfilling from the 1940's or 1950's through 2005. Operable Unit-1 (OU-1) addresses two disposal areas (Areas 1 and 2) where radionuclides are mixed within landfilled soil and solid waste materials, plus an adjacent area (the Buffer Zone/Crossroad Property) where erosion from Area 2 deposited radiologically-impacted materials (RIM). Operable Unit-2 (OU-2) consists of the remainder of the site including areas never used for landfilling, several inactive fill areas containing sanitary waste or demolition debris which were closed prior to state regulation, and a permitted sanitary landfill currently undergoing closure under the State of Missouri's solid waste regulatory program.

Consistent with the National Oil and Hazardous Substance Contingency Plan (NCP), 40 CFR § 300.430 (EPA, 2009a), a Remedial Investigation (RI) and Feasibility Study (FS) were previously completed for OU-1 and approved by the United States Environmental Protection Agency (EPA) in 2006. Based on those reports, EPA developed a Proposed Plan for OU-1 and, after an extended public comment process including three public meetings, issued a Record of Decision (ROD) in 2008. The ROD-selected remedy called for containing the RIM and solid waste materials with a new multi-layered engineered landfill cover system, long-term operation and maintenance and environmental monitoring, and land use controls including deed restrictions.

In January 2010, EPA determined that a Supplemental Feasibility Study (SFS) should be prepared for OU-1 to evaluate two additional potential remedial alternatives. Specifically, EPA requested that the OU-1 Respondents perform an updated engineering and cost analysis of the ROD-selected remedy, and a similar analysis of two new alternatives which would excavate all RIM in excess of a specified cleanup level from OU-1 and either send the excavated materials to a permitted, out-of-state landfill for disposal ("complete rad removal" with off-site disposal), or re-dispose of the excavated material in a new engineered landfill cell to be built within the boundaries of the West Lake Landfill site ("complete rad removal" with on-site disposal).

This Executive Summary summarizes the findings and conclusions of the SFS. Briefly stated:

- All three remedial alternatives -- the ROD-selected remedy and both "complete rad removal" alternatives -- meet EPA's criteria for long-term protection of human health, welfare and the environment.
- The ROD-selected remedy and the "complete rad removal" with off-site disposal alternatives appear implementable. The "complete rad removal" with on-site disposal alternative has potential implementability issues caused by proximity to Lambert-St. Louis International Airport and regulatory and contractual restrictions on the disposal of putrescible solid waste near the Airport's runways. The two "complete rad removal" alternatives also pose a greater potential bird or other wildlife hazard to aircraft and airport facilities because performing either would open up larger areas of the landfilled waste to excavation and take longer to complete than the ROD-selected remedy.

- While all three alternatives have long-term risks within EPA's acceptable risk range, the risks (at 1,000 years) of the "complete rad removal" with off-site disposal alternative are better than the other two alternatives.
- The short-term risks to on-site workers and to the community are worse under either of the "complete rad removal" alternatives than under the ROD-selected remedy, and short-term risks to workers associated with the "complete rad removal" alternatives are outside of EPA's acceptable risk range.
- The time required to implement the ROD-selected remedy is the shortest, followed by the off-site and then the on-site "complete rad removal" disposal alternatives.
- The cost estimate for the ROD-selected remedy is the lowest, followed by the on-site and then the off-site "complete rad removal" disposal alternatives.

Table ES-1 summarizes in numerical format the results of the SFS evaluation of long-term risks, short-term risks, time to achieve the remedial action objectives, and the anticipated costs of each of the alternatives.

| Table ES-1 S | | ISKS, IMPLEMENTATION SCH L SFS REMEDIAL ALTERNATI | |
|--|---|---|--|
| • | ROD-Selected Remedy | "Complete Rad Removal" with Off-site Disposal | "Complete Rad Removal" with On-Site Disposal |
| Long term residual cancer risk 1,000 years after cleanup | 1.3 x 10 ⁻⁶ (1.3 extra incidences in 1,000,000 people) | <1 x 10 ⁻⁷ (less than 0.1 extra incidence in 1,000,000 people) | 1.5 x 10 ⁻⁶ (1.5 extra incidences in 1,000,000 people) |
| | On-Site Workers Industrial accidents: 4.7 Cancer risk: 7.2 x 10 ⁻⁵ (0.72 extra incidences in 10,000 people) Worker dose: 50 mrem/yr | On-Site Workers Industrial accidents: 7.6 Cancer risks: 7.6 x 10 ⁻⁴ (7.6 extra incidences in 10,000 people) Worker dose: 260 mrem/yr | On-Site Workers Industrial accidents: 9.0 Cancer risks: 7.4 x 10 ⁻⁴ (7.4 extra incidences in 10,000 people) Worker dose: 260 mrem/yr |
| Short term risks during cleanup | Community Transportation accidents: 0.61 Cancer risk: 3.3 x 10 ⁻⁶ (0.33 extra incidences in 100,000 people) Carbon dioxide emissions: 8,350 tons | Community Transportation accidents: 1.4 Cancer risks: 2.1 x 10 ⁻⁵ (2.1 extra incidences in 100,000 people) Carbon dioxide emissions: 35,400 tons | Community Transportation accidents: 0.79 Cancer risks: 2.0 x 10 ⁻⁵ (2.0 extra incidences in 100,000 people) Carbon dioxide emissions: 17,900 tons |
| Schedule to reach cleanup goals | 3 years (or 5 years at spend rate of \$10M per year) | 4 years (or 29 years at spend rate of \$10M per year) | 6 years (or 13 years at spend rate of \$10M per year) |
| Costs | Capital construction: \$41,400,000 OM&M per year: \$42,000 to \$414,000 | Capital construction: \$259,000,000 to \$415,000,000 OM&M per year: \$40,000 to \$412,000 | Capital construction: \$117,000,000 OM&M per year: \$52,000 to \$604,000 |

A. Specifics of the ROD -Selected Remedy and the "Complete Rad Removal" Remedial Alternatives

1) ROD-Selected Remedy

The ROD-selected remedy for OU-1 would protect human health and the environment through a new multi-layered engineered landfill cover system and institutional controls for the landfilled waste materials. A description of and reasons for selection of this remedy are presented in EPA's ROD for OU-1 (EPA, 2008a). The engineered cover and institutional control measures would prevent human receptors from contacting the waste material. The source control measures also would mitigate contaminant migration to air and restrict infiltration of precipitation into the landfill, which contributes to protection of groundwater quality.

The major components of the ROD-selected remedy for OU-1 are as follows:

- Installation of a landfill cover meeting the Missouri closure and post-closure care requirements for sanitary landfills including enhancements consistent with the standards for uranium mill tailing sites, i.e., armoring layer and radon barrier;
- Consolidation of radiologically contaminated surface soil from the Buffer Zone/Crossroad Property to the containment area;
- Application of groundwater monitoring and protection standards consistent with the requirements for uranium mill tailing sites and sanitary landfills;
- Surface water runoff control;
- Gas monitoring and control including radon and decomposition gas, as necessary;
- Institutional controls to prevent land and resource uses that are inconsistent with a closed sanitary landfill containing long-lived radionuclides; and
- Long-term surveillance and maintenance of the remedy.

Performance standards for each of the remedy components are specified in the ROD.

As a result of subsequent discussions between EPA Region 7 and EPA's Office of Superfund Remediation and Technology Innovation (OSRTI), additional performance standards have been identified for the ROD-selected remedy. The SFS analysis incorporates those additional performance standards, along with other information obtained during development of a draft remedial design work plan, for the ROD-selected remedy.

2) Definition of "Complete Rad Removal"

In a January 11, 2010, letter and associated Statement of Work (SOW), EPA specified the two "complete rad removal" alternatives to be evaluated as part of the SFS (in addition to the ROD-selected remedy) as follows:

- 1. Excavation of radioactive materials with off-site commercial disposal of the excavated materials (referred to as "complete rad removal" with off-site disposal alternative); and
- 2. Excavation of radioactive materials with on-site disposal of the excavated materials in an on-site engineered disposal cell with a liner and cap if a suitable location outside the geomorphic flood plain can be identified (referred to as "complete rad removal" with on-site disposal alternative).

EPA indicated that "complete rad removal" means attainment of the risk-based radiological cleanup levels specified in U.S. EPA's Office of Solid Waste and Emergency Response (OSWER) Directives 9200.4-25 and 9200.4-18 (EPA, 1998a and 1997a).

Although the new excavation alternatives have been termed "complete rad removal," implementation of either of these alternatives would not actually remove all RIM from the site, but instead would remove sufficient RIM from OU-1 such that additional engineering and institutional controls would not be required based on the radiological content of these areas. Because Areas 1 and 2 would still contain landfilled solid wastes after removal of the RIM, regrading and capping the landfills and establishing land use controls at Areas 1 and 2 would still be necessary.

3) "Complete Rad Removal" with Off-Site Disposal Alternative

The "complete rad removal" with off-site disposal alternative includes the following components:

- Excavating and stockpiling uncontaminated soil and waste (overburden) in Areas 1 and 2 in order to access the RIM, then excavating RIM from Areas 1 and 2 until the level of remaining radionuclides is low enough to allow for unrestricted use based on the presence of radionuclides. This excavation stage also includes surveying and identifying the presence and extent of RIM on the Buffer Zone/Crossroad Property, with excavation of any RIM that contains radionuclides at levels greater than those that would allow for unrestricted use;
- Surface water runoff control;
- Loading, transporting cross-country, and disposing of excavated RIM and impacted soil at an off-site disposal facility;
- Replacing the stockpiled overburden and regrading the remaining solid waste materials, then installing a landfill cover meeting the Missouri Department of Natural Resources (MDNR) closure and post-closure care requirements for sanitary landfills over Areas 1 and 2;
- Application of groundwater monitoring and protection standards consistent with the requirements for uranium mill tailing sites and sanitary landfills;

- Gas monitoring and control, as necessary;
- Institutional controls to prevent land and resource uses that are inconsistent with a closed sanitary landfill; and
- Long-term surveillance and maintenance of the remedy.

4) "Complete Rad Removal" with On-Site Disposal Alternative

The "complete rad removal" with on-site disposal alternative includes the following components:

- Excavating stockpiled soil from the current OU-2 on-site soil borrow and stockpile area and relocating the soil material to the area of the previously closed leachate lagoon, then constructing the liner system for the on-site engineered disposal cell at the site of the current OU-2 on-site soil borrow and stockpile area;
- Excavating and stockpiling uncontaminated soil and waste (overburden) in Areas 1 and 2 in order to access the RIM, then excavating from Areas 1 and 2 RIM materials that contain radionuclides above levels would allow for unrestricted use based on the presence of radionuclides;
- Surveying and identifying the presence and extent of RIM on the Buffer Zone/Crossroad Property, and excavating any RIM that contains radionuclides at levels greater than those that would allow for unrestricted use;
- Loading and transporting the excavated RIM and impacted soil to the on-site
 engineered disposal cell and placement and compaction of the RIM in the cell, then
 closing the on-site cell with a final cover configuration consistent with both the
 MDNR solid waste regulations and Uranium Mine Tailings Radiation Control Act
 (UMTRCA) requirements, plus leachate monitoring and control for the on-site cell, as
 necessary;
- Replacing the stockpiled overburden and regrading the remaining solid waste materials in Areas 1 and 2, then installing a landfill cover meeting the Missouri closure and post-closure care requirements for sanitary landfills over Areas 1 and 2;
- Surface water runoff control;
- Application of groundwater monitoring and protection standards consistent with the requirements for uranium mill tailing sites and sanitary landfills;
- Gas monitoring and control including radon and decomposition gas, as necessary;
- Institutional controls to prevent land and resource uses that are inconsistent with a closed sanitary landfill containing long-lived radionuclides; and
- Long-term surveillance and maintenance of the remedy.

B. Detailed Evaluation of Remedial Alternatives

The two "complete rad removal" alternatives along with the ROD-selected remedy were evaluated using the threshold and primary balancing criteria set forth in the NCP. These criteria include the following:

- Threshold Criteria:
 - Overall Protection of Human Health and the Environment;
 - Compliance with applicable or relevant and appropriate requirements (ARARs) of other regulations.
- Primary Balancing Criteria:
 - Long-term Effectiveness and Permanence;
 - Reduction of Toxicity, Mobility, or Volume through Treatment;
 - Short-term Effectiveness;
 - Implementability; and
 - Cost.

The NCP also requires EPA to evaluate remedial alternatives in terms of two Modifying Criteria -- state and community acceptance. Pursuant to EPA direction, state and community acceptance are not evaluated in the SFS but will be considered as part of any decision process that may be undertaken by EPA after completion of the SFS.

C. Results of the Detailed Evaluation of the Remedial Alternatives

Each SFS-specific alternative was evaluated against the seven NCP criteria listed above. A comparative analysis of the alternatives was also performed to identify the relative advantages and disadvantages of each alternative and trade-offs among the alternatives in terms of the NCP criteria.

1) Protection of Human Health and the Environment

All of the alternatives are protective of human health and the environment. Installation of a new multi-layer engineered landfill cover system at Areas 1 and 2 pursuant to the ROD-selected remedy and excavation of RIM under both "complete rad removal" alternatives would reduce potential risks from exposure to external gamma radiation or radon gas emissions from the RIM. Likewise, installation of a multi-layer engineered landfill cover over a new engineered disposal cell as part of the "complete rad removal" with on-site disposal alternative would reduce potential risks from exposure to external gamma radiation or radon gas emissions from excavated RIM.

Installation of a new multi-layer engineered landfill cover over Areas 1 and 2 is included as part of all of the alternatives and would eliminate potential risks associated with non-radiological contaminants via inhalation or ingestion of contaminated soils or wastes, dermal contact with contaminated soils or wastes, and wind dispersal of fugitive dust. Installation of such a cover over Areas 1 and 2 also would greatly reduce the potential for infiltration of water via rain or

snow precipitation and thus the potential for leaching of contaminants from wastes into groundwater. Finally, installation of a liner system beneath a new, engineered disposal cell included in the "complete rad removal" with on-site disposal alternative would further reduce the potential for leaching to groundwater for those waste materials that are placed in the cell.

2) <u>Compliance with ARARs</u>

The SFS analyzed each alternative's compliance with the three types of ARARs identified by the NCP: chemical specific, location-specific, and action-specific (*i.e.*, inherent in the cleanup option under evaluation).

All of the alternatives will meet chemical-specific ARARs consisting of: the uranium mill tailings and National Emissions Standard for Hazardous Air Pollutants (NESHAP) standards for radon emissions; the uranium mill tailings standards for cleanup of contaminated land (Buffer Zone/Crossroad property), as modified by the EPA OSWER directives regarding use of these standards at Superfund sites; Missouri state radiation protection standards; the maximum concentrations for groundwater protection under the uranium mill tailing standards; and the Missouri maximum contaminant levels (MCLs) for groundwater.

The ROD-selected remedy and the "complete rad removal" with off-site disposal alternative would meet the location-specific ARARs found in the Missouri solid waste regulations for landfills located within a 100-year floodplain or within 10,000 feet of an airport runway. The "complete rad removal" with on-site disposal alternative could be designed to meet most but possibly not all of the location-specific ARARs and To-Be-Considered (TBC) criteria. The on-site engineered disposal cell alternative would not meet a Federal Aviation Administration (FAA) advisory criterion (a TBC) for siting new landfill units within certain distances of airports. In addition, siting the on-site engineered disposal cell in the only location which satisfies EPA's instructions (located on-site and outside the geomorphic floodplain) also would conflict with the Negative Easement and Restrictive Covenant (Restrictive Covenant) previously purchased by the City of St. Louis from the site owners. The Restrictive Covenant prohibits any new or additional deposition or dumping of municipal waste, organic waste, and putrescible waste above, upon, on, or under the West Lake property in order to reduce or mitigate wildlife hazards to aircraft and airport facilities. The Restrictive Covenant is not a federal or state regulation and so is not an ARAR, but may qualify as a TBC.

Finally, the ROD-selected remedy and the "complete rad removal" with off-site disposal alternative would meet the requirements of all action-specific ARARs, while the "complete rad removal" with on-site disposal alternative would meet most but not all of these requirements. All three alternatives would meet the Missouri closure and post-closure standards for solid waste landfills, the Missouri radiation protection standards, and the Missouri noise protection standards during implementation of a remedial action and closure of Areas 1 and 2. The new engineered disposal cell included in the "complete rad removal" with on-site disposal alternative would meet the Missouri solid waste regulations for design, operation, closure and post-closure standards for a new solid waste landfill; however, it would not meet the prohibition against disposal in a solid waste cell of radioactively-contaminated material resulting from the cleanup of a radioactively-

contaminated waste disposal site. There does not appear to be a basis for waiver of this requirement.

3) <u>Long-Term Effectiveness and Permanence (Including Long-Term Risks)</u>

All of the alternatives result in waste materials remaining on site and therefore require the installation, maintenance and monitoring of one or more landfill caps (engineered containment structures) and land use controls. Under the "complete rad removal" with off-site disposal alternative, no RIM would remain on site at levels above those that would allow for unrestricted use relative to the presence of radionuclides.

Engineered containment is the primary method that would be used to control both radiological and non-radiological waste materials that remain on site. The primary engineering measures included in all three alternatives are construction, inspection, and maintenance of multi-layer engineered landfill cover systems (*i.e.*, caps) over Areas 1 and 2.

Under the ROD-selected remedy, the new cap would be designed to reduce potential exposures to gamma radiation and to reduce actual radon emissions to acceptable levels, including the expected increased levels of gamma radiation and radon emissions that will occur with 1,000 years of radioactive decay of thorium. The new cap would also prevent potential exposure to non-radiological contaminants in the Areas 1 and 2 solid waste landfill materials. Under the "complete rad removal" with on-site disposal alternative, the RIM would be excavated and placed in a new engineered on-site disposal cell that would be designed to achieve the same results – reduce potential exposures to current and 1,000 year levels of gamma radiation and radon emissions. Lastly, the "complete rad removal" with off-site disposal alternative would excavate and transport the RIM off-site for disposal, thereby reducing on-site potential exposures to gamma radiation and radon emissions. Both the on-site and the off-site "complete rad removal" disposal alternatives would also include the construction, inspection and maintenance of a cap over Areas 1 and 2 after RIM removal to protect against exposure to non-radiological contaminants remaining in these solid waste landfills.

The engineering measures implemented under each alternative would be augmented and supported by maintenance of current land use restrictions in place at the site, plus implementation of additional institutional controls as necessary. Institutional controls would limit future uses of the land and resources at the site so as to eliminate or restrict potential exposure to the wastes or contaminated media, and to reduce the potential for future land uses which could impact or reduce the effectiveness of the engineered measures.

The long-term (1,000 year) non-cancer risks associated with each of the alternatives are essentially the same, and the residual cancer risks posed are below or within EPA's target risk range of 1 additional cancer incidence in 1,000,000 people [1 x 10^{-6}] to 1 additional incidence in 10,000 people [1 x 10^{-4}].

4) Reduction of Toxicity, Mobility or Volume Through Treatment

None of the alternatives include treatment technologies that would reduce the toxicity, mobility, or volume of the waste materials through treatment. Treatment technologies are generally not applicable to solid waste landfills because of the large volume of waste which is deposited in a landfill. For the RIM interspersed within the solid waste at OU-1, the radionuclides are naturally occurring elements (primarily isotopes of uranium, thorium, radium and daughter decay products such as radon), which cannot be neutralized or destroyed by treatment. The radionuclides within Areas 1 and 2 are intermixed with soil material which is further dispersed throughout an overall matrix of municipal refuse, construction and demolition debris, and other nonimpacted soil materials. Consequently, separating and removing the RIM from the landfill matrix for aboveground, ex-situ treatment techniques are considered impracticable. In addition, the uneven, heterogeneous nature of the solid waste materials and the unpredictable dispersal of the radionuclides within the overall solid waste matrix make underground treatment in place using in-situ treatment techniques equally impracticable.

It is theoretically possible to reduce the volume of materials handled as RIM (but not the overall total volume of waste materials in Areas 1 and 2) by using a physical separation processes such as shredding and sorting. While not specifically a "treatment" process, this physical separation process could potentially be employed for the excavation alternatives to reduce the volume of RIM that would be transported to an off-site disposal facility or to an on-site disposal cell. Because such physical separation processes have never been used at a solid waste landfill that contains radiologically-impacted soil, no data exists regarding the potential effectiveness, implementability or cost of using such technologies at this site.

5) Short-Term Effectiveness (Including Short-Term Risks and Schedules)

The greatest potential risks to the community are associated with the "complete rad removal" with off-site disposal alternative. These risks arise largely from the much greater number of truck trips associated with off-site disposal, leading to increased traffic congestion on St. Charles Rock Road and other nearby highways and the associated potential for traffic accidents and fatalities, plus greater greenhouse gas emissions, and greater noise impacts. The projected incidence of traffic accidents is 140% for the "complete rad removal" with off-site disposal alternative, compared to 61% for the ROD-selected remedy and 79% for the "complete rad removal" with on-site disposal alternative. If an on-site rail spur is determined to be feasible (i.e., if it is possible to obtain permits to build an at-grade crossing over St. Charles Rock Road, purchase or lease off-site land for construction of the spur on the other side of the road, and negotiate tie-in and use rights to an existing private rail spur or line), then the projected incidence of traffic accidents for the "complete rad removal" with off-site disposal would decrease slightly to 130%.

In addition, the "complete rad removal" with off-site disposal alternative is the only alternative that includes the potential for an off-site release resulting from potential vehicle accidents or other losses of vehicle or container integrity during cross-country material transport, handling and transfer activities. Projected carbon dioxide (greenhouse gas) emissions are also substantially greater for the "complete rad removal" with off-site disposal alternative: 35,400

tons of carbon dioxide compared to 8,350 tons and for the ROD remedy and 17,900 tons for the "complete rad removal" with on-site disposal alternative.

Another potential local risk considered was from fugitive dust emissions during implementation of each alternative. Potential carcinogenic risks to local community residents resulting from fugitive dust emissions during project construction (assuming no mitigation measures are employed or the mitigation measures prove ineffective) are greatest for the "complete rad removal" alternatives, estimated at 2 additional cancer incidences in 100,000 people [2 x 10⁻⁵] for the on-site and 2.1 additional cancer incidences in 100,000 people [2.1 x 10⁻⁵] for the off-site alternatives, compared with 0.33 additional cancer incidences in 100,000 [3.3 x 10⁻⁶] from the ROD-selected remedy. However, the potential carcinogenic risks to off-site residents for all three alternatives are within EPA's range of acceptable risks (10⁻⁴ to 10⁻⁶).

The highest potential risks to on-site workers are also associated with the two "complete rad removal" alternatives due to the greater amount of handling of RIM required for these alternatives. In addition, because implementation of the excavation remedies will take longer than the ROD-selected remedy, those two alternatives would subject workers to gamma radiation exposures over a longer time period.

The projected incidence of industrial accidents is greater for the two "complete rad removal" alternatives (7.6 for the off-site and 9 for the on-site alternatives) compared to those for the ROD-selected remedy (4.7). The potential risks to workers from exposure to carcinogenic substances and gamma radiation is ten times higher for the "complete rad removal" alternatives: 7.6 extra incidences in 10,000 people for the off-site and 7.4 for the on-site "complete rad removal" alternatives (7.6 and 7.4 x 10⁻⁴, respectively), compared to 0.72 extra incidences in 10,000 people (7.2 x 10⁻⁵) for the ROD-selected remedy. The gamma exposure to an on-site worker is projected to be 260 millirems per year (mrem/year) for either the off-site and on-site "complete rad removal" alternatives, compared with only 50 mrem/year of projected exposure under the ROD-selected remedy. The "complete rad removal" alternatives pose the greatest risks to on-site workers due to the greater amount (both in degree and duration) of handling of waste materials generally, and RIM specifically, required for these alternatives.

No measurable long-term impacts to plants or animals in surrounding ecosystems are expected to occur from any of the alternatives.

For each of the SFS-specific alternatives, Remedial Action Objectives (RAOs) would be achieved upon completion of construction, which is estimated at the following time frames (calculated from EPA's issuance of notice to proceed with remedial design):

- approximately 3 years for the ROD-selected remedy,
- approximately 4 years for the "complete rad removal" with off-site disposal alternative, and
- approximately 6 years for the "complete rad removal" with on-site disposal alternative.

These estimated durations assume that remedial design (RD) for each alternative can be completed and approved within one year of remedy approval and authorization to begin the RD phase, and that construction of the remedy is not fiscally constrained. Under a fiscally constrained approach in which project expenditures are limited to \$10 million per year, the estimated time frames for remedial design and construction completion increase to 5 years for the ROD-selected remedy, 29 years for the "complete rad removal" with off-site disposal alternative, and 13 years for the "complete rad removal" with on-site disposal alternative.

6) <u>Implementability</u>

All of the alternatives would use standard technologies that are routinely applied at closed sanitary landfills such as regrading or excavating portions of the landfill mass, installation and maintenance of an engineered landfill cover, monitoring of landfill gas and groundwater quality, fencing and other access restrictions, and institutional controls. Each alternative therefore is considered to be technically implementable. For the two "complete rad removal" alternatives, questions arise regarding the ability to remove all of the RIM from Area 2 due to the depth of the RIM and proximity of the RIM to closed or inactive landfill units at OU-2. Excavation of RIM would also present significant implementability concerns associated with the excavation and handling of non-radiological contaminated materials; management of fugitive dust and potential odors; mitigation of bird and wildlife hazards; management and treatment of stormwater exposed to RIM during excavation; management of liquid RIM that fails the paint filter liquids test; and the identification, segregation, and disposal off-site of any hazardous wastes or regulated asbestos containing materials (ACM) that may be encountered during RIM excavation.

The Restrictive Covenant held by the City of St. Louis for the benefit of Lambert-St. Louis International Airport could affect the administrative implementability of the "complete rad removal" with on-site disposal alternative. The greater areal extent of refuse that would be disturbed under the two "complete rad removal" alternatives, combined with the greater amount of time required to implement these two alternatives, poses the greatest potential for creation of wildlife hazards to the nearby Lambert-St. Louis International Airport. In addition, the Missouri solid waste regulatory prohibition against the disposal of radioactively-contaminated material resulting from the cleanup of radioactively-contaminated sites in a solid waste landfill cell could also affect the administrative implementability of this alternative.

7) Cost

The final balancing criterion is cost.

- The ROD-selected remedy would result in the lowest overall capital (design, construction and environmental monitoring during construction) costs of all of the alternatives at \$41 million, with estimated annual operation, maintenance and monitoring (OM&M) costs ranging from \$42,000 to \$414,000.
- Implementation of the "complete rad removal" with off-site disposal alternative would result in the highest total capital cost at \$259 to \$415 million (depending upon which off-

site disposal facility is used), with estimated annual OM&M costs of \$40,000 to \$412,000.

• Implementation of the "complete rad removal" with on-site disposal alternative would result in a capital cost of \$117 million, with estimated annual OM&M costs of \$52,000 to \$604,000.

Ranges in values for the annual OM&M costs result from variations in the specific activities that occur each year (e.g. additional monitoring, maintenance repairs or five-year reviews).